Message

From: Corbin, Mark [Corbin.Mark@epa.gov]
Sent: 10/5/2018 5:31:04 PM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
CC: Odenkirchen, Edward [Odenkirchen.Edward@epa.gov]; Anderson, Brian [Anderson.Brian@epa.gov]; Peck, Charles [Peck.Charles@epa.gov]; Farruggia, Frank [Farruggia.Frank@epa.gov]
Subject: Phone Call
Attachments: one pager update norsworthy 100518.docx

Dr Norsworthy

Thank you for taking the time out yesterday to walk us through your data and answer all of the questions we need to address. To that end we have drafted a one-pager for our management to summarize the points we discussed and the responses. We would like to run that by you to ensure that it accurately reflects your take on what we discussed and the points that were made.

I realize you are busy but if you have time please take a look at the attached summary and provide and any feedback you can it would be much appreciated. And of course if you have any questions please let me know. We are off Monday for Columbus day but I will be around Tuesday.

Thank you again

Mark Corbin
Branch Chief, Environmental Risk Branch 6
Environmental Fate and Effects Division (7507P)
Office of Pesticide Programs
U.S. Environmental Protection Agency
Washington DC 20460
703-605-0033

Message

From: Peck, Charles [Peck.Charles@epa.gov]
Sent: 10/15/2018 7:43:05 PM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
CC: Baris, Reuben [Baris.Reuben@epa.gov]; Corbin, Mark [Corbin.Mark@epa.gov]; Odenkirchen, Edward [Odenkirchen.Edward@epa.gov]; Anderson, Brian [Anderson.Brian@epa.gov]; Echeverria, Marietta [Echeverria.Marietta@epa.gov]
Subject: RE: Question Regarding Jones Thesis

Thanks Jason!

From: Jason Keith Norsworthy [mailto:jnorswor@uark.edu]
Sent: Monday, October 15, 2018 3:15 PM
To: Peck, Charles <Peck.Charles@epa.gov>
Cc: Baris, Reuben <Baris.Reuben@epa.gov>; Corbin, Mark <Corbin.Mark@epa.gov>; Odenkirchen, Edward <Odenkirchen.Edward@epa.gov>; Anderson, Brian <Anderson.Brian@epa.gov>
Subject: Re: Question Regarding Jones Thesis

He defended 6 months ago. It has been accepted by the University of AR Grad School.

Sent from my iPhone

On Oct 15, 2018, at 10:08 AM, Peck, Charles <Peck.Charles@epa.gov> wrote:

> Hi Dr. Norsworthy,
>
> Quick question regarding G. Travis Jones 2018 Master's thesis titled "Evaluation of Dicamba Off-Target Movement and Subsequent Effects on Soybean Offspring". Has Mr. Jones defended his thesis yet and has it been approved by the committee members and the university?
>
> Thank you for your quick responses to all my questions! They have been a huge help!
>
> Chuck Peck
> OPP/EFED/ERB VI
> Potomac Yard South
> Crystal City, VA
> Room 10244
> (703) 347-8064
> peck.charles@epa.gov

Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 10/15/2018 7:15:26 PM
To: Peck, Charles [Peck.Charles@epa.gov]
CC: Baris, Reuben [Baris.Reuben@epa.gov]; Corbin, Mark [Corbin.Mark@epa.gov]; Odenkirchen, Edward [Odenkirchen.Edward@epa.gov]; Anderson, Brian [Anderson.Brian@epa.gov]
Subject: Re: Question Regarding Jones Thesis

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> peck.charles@epa.gov

Message

From: Peck, Charles [Peck.Charles@epa.gov]
Sent: 10/15/2018 4:08:16 PM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
CC: Baris, Reuben [Baris.Reuben@epa.gov]; Corbin, Mark [Corbin.Mark@epa.gov]; Odenkirchen, Edward [Odenkirchen.Edward@epa.gov]; Anderson, Brian [Anderson.Brian@epa.gov]
Subject: Question Regarding Jones Thesis

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Chuck Peck
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Potomac Yard South
Crystal City, VA
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peck.charles@epa.gov

Appointment

From: ONeill, Sandra [ONeill.Sandra@epa.gov]
Sent: 8/13/2018 5:37:27 PM
To: ONeill, Sandra [ONeill.Sandra@epa.gov]; jnorswor@uark.edu; hartzler@iastate.edu; jason.bond@msstate.edu; loux.1@osu.edu; gunso001@umn.edu; Thomas.J.Peters@ndsu.edu; sharon.clay@sdstate.edu; dpeterso@ksu.edu; todd.baughman@okstate.edu; DStephenson@agcenter.lsu.edu; scott.nolte@tamu.edu; GA [xzl0004@auburn.edu]; stanley@uga.edu; marsha3@clemson.edu; lsteckel@tennessee.edu; hager@illinois.edu; mjv@udel.edu; wgj@purdue.edu; IN, Joe Ikely [jikley@purdue.edu]; WI, Rodrigo Werle [rwerle@wisc.edu]; NE, Amit Jhala [amit.jhala@unl.edu]; MI, Christie Sprague [sprague1@msu.edu]; KT, JD Green [jdgreen@uky.edu]; TX, Peter Dotray [p-dotray@tamu.edu]; VA, Michael Flessner [flessner@vt.edu]; PA, Dwight Lingenfelter [dxl18@psu.edu]; AK, Tom Barber [tbarber@uaex.edu]; Meadows, Sarah [Meadows.Sarah@epa.gov]; Baris, Reuben [Baris.Reuben@epa.gov]; Kenny, Daniel [Kenny.Dan@epa.gov]; Schmid, Emily [Schmid.Emily@epa.gov]; Hathaway, Margaret [Hathaway.Margaret@epa.gov]; OPP FEAD GISB [OPP_FEAD_GISB@epa.gov]; Wire, Cindy [Wire.Cindy@epa.gov]; Keller, Kaitlin [keller.kaitlin@epa.gov]; Wormell, Lance [Wormell.Lance@epa.gov]; Emdur, Zoe [Emdur.Zoe@epa.gov]; Ryan, Emily [ryan.emily@epa.gov]; Legleiter, Travis [Travis.Legleiter@uky.edu]; Green, Jonathan [jonathan.green@uky.edu]; tony.cofer@agi.alabama.gov; Leonard, Billy R. [RLeonard@agcenter.lsu.edu]; Kaul, Monisha [Kaul.Monisha@epa.gov]; Chism, William [Chism.Bill@epa.gov]; Becker, Jonathan [Becker.Jonathan@epa.gov]; Biscoe, Melanie [Biscoe.Melanie@epa.gov]; Britton, Cathryn [Britton.Cathryn@epa.gov]; Basu, Bilin [Basu.Bilin@epa.gov]

Subject: Session II: Extension Agent/Weed Scientist Dicamba Discussion with EPA: call in: EOP / Ex. 6 ID # EOP / Ex. 6
Location: DCRoomPYS9100/Potomac-Yard-One

Start: 8/15/2018 6:30:00 PM
End: 8/15/2018 7:30:00 PM
Show Time As: Busy

Conference Number: EOP / Ex. 6
Conference ID: EOP / Ex. 6

All,

This is a second session where we hope to hear from additional states who would like to continue sharing existing dicamba information.

Agenda:
I. Introductions
II. Extension agent/weed scientist summary of current dicamba situation.
III. Extension agent/weed scientist suggestions for label updates, if OTT dicamba registrations were to be extended beyond this year.

Thank you,

Sandra O'Neill
Government Liaison
Government and International Services Branch II Field and External Affairs Division II OPP/OCSPP II U.S. EPA II (703) 347-0141

Appointment

From: ONeill, Sandra [ONeill.Sandra@epa.gov]
Sent: 8/7/2018 8:48:48 PM
To: ONeill, Sandra [ONeill.Sandra@epa.gov]; jnorswor@uark.edu; hartzler@iastate.edu; jason.bond@msstate.edu; loux.1@osu.edu; gunso001@umn.edu; Thomas.J.Peters@ndsu.edu; sharon.clay@sdstate.edu; dpeterso@ksu.edu; todd.baughman@okstate.edu; DStephenson@agcenter.lsu.edu; scott.nolte@tamu.edu; GA [xzl0004@auburn.edu]; stanley@uga.edu; marsha3@clemson.edu; lsteckel@tennessee.edu; hager@illinois.edu; mjv@udel.edu; wgj@purdue.edu; IN, Joe Ikely [jikley@purdue.edu]; WI, Rodrigo Werle [rwerle@wisc.edu]; NE, Amit Jhala [amit.jhala@unl.edu]; MI, Christie Sprague [sprague1@msu.edu]; KT, JD Green [jdgreen@uky.edu]; TX, Peter Dotray [p-dotray@tamu.edu]; VA, Michael Flessner [flessner@vt.edu]; PA, Dwight Lingenfelter [dxl18@psu.edu]; AK, Tom Barber [tbarber@uaex.edu]; Meadows, Sarah [Meadows.Sarah@epa.gov]; Baris, Reuben [Baris.Reuben@epa.gov]; Kenny, Daniel [Kenny.Dan@epa.gov]; Schmid, Emily [Schmid.Emily@epa.gov]; Hathaway, Margaret [Hathaway.Margaret@epa.gov]; OPP FEAD GISB [OPP_FEAD_GISB@epa.gov]
CC: Wire, Cindy [Wire.Cindy@epa.gov]; Keller, Kaitlin [keller.kaitlin@epa.gov]; Wormell, Lance [Wormell.Lance@epa.gov]; Emdur, Zoe [Emdur.Zoe@epa.gov]; Ryan, Emily [ryan.emily@epa.gov]; Legleiter, Travis [Travis.Legleiter@uky.edu]; Green, Jonathan [jonathan.green@uky.edu]

Subject: Extension Agent/Weed Scientist Dicamba Discussion with EPA: call in: EOP / Ex. 6 ID # EOP / Ex. 6
Location: DCRoomPYS7100/Potomac-Yard-One

Start: 8/13/2018 2:00:00 PM
End: 8/13/2018 3:00:00 PM
Show Time As: Busy

Conference Number: EOP / Ex. 6
Conference ID: EOP / Ex. 6

All,

The purpose of this meeting is to share existing dicamba information. Given the short notice, if your state is not able to make the call time, we are happy to discuss outside of the call.

Agenda:
I. Introductions
II. Extension agent/weed scientist summary of current dicamba situation.
III. Extension agent/weed scientist suggestions for label updates, if OTT dicamba registrations were to be extended beyond this year.

Thank you,

Sandra O'Neill
Government Liaison
Government and International Services Branch II Field and External Affairs Division II OPP/OCSPP II U.S. EPA II (703) 347-0141

Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 8/14/2018 2:37:30 AM
To: Baris, Reuben [Baris.Reuben@epa.gov]
Subject: Wednesday meeting

Reuben,

You may want to add Kevin Bradley to your list of invitees. Somehow he was not included. Likely my oversight.

Regards,
Jason

Sent from my iPhone

Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 8/8/2018 12:56:32 AM
To: Baris, Reuben [Baris.Reuben@epa.gov]
Subject: Re: List help

Are you planning to visit with weed scientists in the coming week? It would be great to hear an update from each state. How was your NE visit?

Jason

Sent from my iPhone

On Aug 6, 2018, at 9:15 PM, Baris, Reuben <Baris.Reuben@epa.gov> wrote:

> Thanks Jason. What about the ones at the bottom. Or are you saying who we picked are the right folks? Thanks again.
>
> Mi - Christie sort (??? Christie Sprague sprague1@msu.edu)
> KT, - Amet Greg (??? Greg Armel garmel@utk.edu)
> tx - peter douchere (??? Peter Dotray p-dotray@tamu.edu)
> Va - Mike cleaner (??? Michael Flessner flessner@vt.edu)
> Pa- ? (??? Dwight Lingenfelter dxl18@psu.edu)
>
> REUBEN BARIS | PRODUCT MANAGER, TEAM 25 | HERBICIDE BRANCH
> U.S. ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF PESTICIDE PROGRAMS | (703) 305-7356
>
> **From:** Jason Keith Norsworthy [mailto:jnorswor@uark.edu]
> **Sent:** Monday, August 06, 2018 6:36 PM
> **To:** Baris, Reuben <Baris.Reuben@epa.gov>
> **Subject:** Re: List help
>
> All of these appear correct.
>
> Jason
>
> Sent from my iPhone
>
> On Aug 6, 2018, at 4:12 PM, Baris, Reuben <Baris.Reuben@epa.gov> wrote:
>
>> Hey Jason,
>> Can you help fill in the gaps from Dan's chicken scratch? Thank you.
>>
>> IA, Bob Hartzler hartzler@iastate.edu
>> MS, Jason Bond jason.bond@msstate.edu
>> OH, Mark Loux loux.1@osu.edu
>> MN, Jeff Gonsulus gunso001@umn.edu
>> ND, Tom Peters Thomas.J.Peters@ndsu.edu
>> SD, Sharon Clay sharon.clay@sdstate.edu
>> KS, Dallas Peterson dpeterso@ksu.edu
>> OK, Todd Baughman todd.baughman@okstate.edu

LA, Daniel Stephenson DStephenson@agcenter.lsu.edu
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AL, Steve Li xzl0004@auburn.edu
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Pa- ? (??? Dwight Lingenfelter dxl18@psu.edu)

Appointment

From: ONeill, Sandra [ONeill.Sandra@epa.gov]
Sent: 8/7/2018 8:48:47 PM
To: jnorswor@uark.edu; hartzler@iastate.edu; jason.bond@msstate.edu; loux.1@osu.edu; gunso001@umn.edu; Thomas.J.Peters@ndsu.edu; sharon.clay@sdstate.edu; dpeterso@ksu.edu; todd.baughman@okstate.edu; DStephenson@agcenter.lsu.edu; scott.nolte@tamu.edu; GA [xzl0004@auburn.edu]; stanley@uga.edu; marsha3@clemson.edu; lsteckel@tennessee.edu; hager@illinois.edu; mjv@udel.edu; wgj@purdue.edu; IN, Joe Ikely [jikley@purdue.edu]; WI, Rodrigo Werle [rwerle@wisc.edu]; NE, Amit Jhala [amit.jhala@unl.edu]; MI, Christie Sprague [sprague1@msu.edu]; KT, JD Green [jdgreen@uky.edu]; TX, Peter Dotray [p-dotray@tamu.edu]; VA, Michael Flessner [flessner@vt.edu]; PA, Dwight Lingenfelter [dxl18@psu.edu]; AK, Tom Barber [tbarber@uaex.edu]; Meadows, Sarah [Meadows.Sarah@epa.gov]; Baris, Reuben [Baris.Reuben@epa.gov]; Kenny, Daniel [Kenny.Dan@epa.gov]; Schmid, Emily [Schmid.Emily@epa.gov]; Hathaway, Margaret [Hathaway.Margaret@epa.gov]; OPP FEAD GISB [OPP_FEAD_GISB@epa.gov]

Subject: Extension Agent/Weed Scientist Dicamba Discussion with EPA: call in: EOP / Ex. 6 ID # EOP / Ex. 6
Location: DCRoomPYS7100/Potomac-Yard-One

Start: 8/13/2018 2:00:00 PM
End: 8/13/2018 3:00:00 PM
Show Time As: Tentative

Conference Number: EOP / Ex. 6
Conference ID: EOP / Ex. 6

All,

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Government Liaison
Government and International Services Branch II Field and External Affairs Division II OPP/OCSPP II U.S. EPA II (703) 347-0141

Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 8/7/2018 12:19:03 PM
To: Baris, Reuben [Baris.Reuben@epa.gov]
Subject: Re: List help

4:30 EST

Sent from my iPhone

On Aug 7, 2018, at 6:22 AM, Baris, Reuben <Baris.Reuben@epa.gov> wrote:

> No I wasn't invited. But I talked with Lee about it when I was in nebraska. When is the call?
>
> Sent from my iPhone
>
> On Aug 7, 2018, at 7:10 AM, Jason Keith Norsworthy <jnorswor@uark.edu> wrote:
>
>> You can add tbarber@uaex.edu.
>>
>> Will you be on the WSSA call today with Nancy Beck and others from EPA?
>>
>> Jason
>>
>> Sent from my iPhone
>>
>> On Aug 6, 2018, at 9:35 PM, Baris, Reuben <Baris.Reuben@epa.gov> wrote:
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>>> One was missing....want me to add Barber? ☺
>>>
>>> AR
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>>> U.S. ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF PESTICIDE PROGRAMS
>>> | (703) 305-7356
>>>
>>> **From:** Jason Keith Norsworthy [mailto:jnorswor@uark.edu]
>>> **Sent:** Monday, August 06, 2018 10:27 PM
>>> **To:** Baris, Reuben <Baris.Reuben@epa.gov>
>>> **Subject:** Re: List help
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KT, - Amet Greg (??? Greg Armel garmel@utk.edu)
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From: Jason Keith Norsworthy [mailto:jnorswor@uark.edu]
Sent: Monday, August 06, 2018 6:36 PM
To: Baris, Reuben <Baris.Reuben@epa.gov>
Subject: Re: List help

All of these appear correct.

Jason

Sent from my iPhone

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IN, Joe Ikely jikley@purdue.edu
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dxl18@psu.edu)

Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 8/14/2018 7:59:46 PM
To: Baris, Reuben [Baris.Reuben@epa.gov]
Subject: dicamba

Reuben,

I don't want to bring this up on the call tomorrow but dicamba is moving in my large drift trial that I have with Monsanto (the one you saw in Proctor, AR) with the irrigation events. Several folks from Monsanto have looked at it and agree that the damage on the North end of the field is because of water moving along the furrows that are typically used for irrigation in our geography. The upper 400 ft of the northern field was irrigated 11 days after application and again 23 days after application. Based on symptomology dicamba appeared to move approximately 1000 ft to the end of the field and leave the field in water in the ditch. There is also damage on all four sides of this field but damage caused by drift, volatility, etc. on the North side is confounded by water moving off the treated Xtend beans.

I look forward to the call tomorrow.

Regards,
Jason

Jason Norsworthy, PhD
Professor and Elms Farming Chair of Weed Science
1366 West Altheimer Dr.
Fayetteville, AR 72704
Tel: 479-575-8740
Mob: 479-313-1265

Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 8/7/2018 11:10:12 AM
To: Baris, Reuben [Baris.Reuben@epa.gov]
Subject: Re: List help

You can add tbarber@uaex.edu.

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Jason

Sent from my iPhone

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Sent: Monday, August 06, 2018 6:36 PM
To: Baris, Reuben <Baris.Reuben@epa.gov>
Subject: Re: List help

All of these appear correct.

Jason

Sent from my iPhone

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> SC, Mike Marshall marsha3@clemson.edu
> TN, Larry Steckel lsteckel@tennessee.edu
> IL, Aaron Hager hager@illinois.edu
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> IN, Joe Ikely jikley@purdue.edu
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Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 8/7/2018 2:26:48 AM
To: Baris, Reuben [Baris.Reuben@epa.gov]
Subject: Re: List help

The ones at the bottom are correct except Greg Armel. I think JD Green should be your Kentucky contact. Greg Armel works for BASF unless he has changed positions.

Jason

Sent from my iPhone

On Aug 6, 2018, at 9:15 PM, Baris, Reuben <Baris.Reuben@epa.gov> wrote:

> Thanks Jason. What about the ones at the bottom. Or are you saying who we picked are the right folks? Thanks again.
>
> Mi - Christie sort (??? Christie Sprague sprague1@msu.edu)
> KT, - Amet Greg (??? Greg Armel garmel@utk.edu)
> tx - peter douchere (??? Peter Dotray p-dotray@tamu.edu)
> Va - Mike cleaner (??? Michael Flessner flessner@vt.edu)
> Pa- ? (??? Dwight Lingenfelter dxl18@psu.edu)
>
> REUBEN BARIS | PRODUCT MANAGER, TEAM 25 | HERBICIDE BRANCH
> U.S. ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF PESTICIDE PROGRAMS | (703) 305-7356
>
> **From:** Jason Keith Norsworthy [mailto:jnorswor@uark.edu]
> **Sent:** Monday, August 06, 2018 6:36 PM
> **To:** Baris, Reuben <Baris.Reuben@epa.gov>
> **Subject:** Re: List help
>
> All of these appear correct.
>
> Jason
>
> Sent from my iPhone
>
> On Aug 6, 2018, at 4:12 PM, Baris, Reuben <Baris.Reuben@epa.gov> wrote:
>
>> Hey Jason,
>> Can you help fill in the gaps from Dan's chicken scratch? Thank you.
>>
>> IA, Bob Hartzler hartzler@iastate.edu
>> MS, Jason Bond jason.bond@msstate.edu
>> OH, Mark Loux loux.1@osu.edu
>> MN, Jeff Gonsulus gunso001@umn.edu
>> ND, Tom Peters Thomas.J.Peters@ndsu.edu
>> SD, Sharon Clay sharon.clay@sdstate.edu
>> KS, Dallas Peterson dpeterso@ksu.edu
>> OK, Todd Baughman todd.baughman@okstate.edu

LA, Daniel Stephenson DStephenson@agcenter.lsu.edu
TX, Scott Nolte scott.nolte@tamu.edu
AL, Steve Li xzl0004@auburn.edu
GA, Stanley Culpepper stanley@uga.edu
SC, Mike Marshall marsha3@clemson.edu
TN, Larry Steckel lsteckel@tennessee.edu
IL, Aaron Hager hager@illinois.edu
DE, Mark VanGessel mjv@udel.edu
IN, Bill Johnson wgj@purdue.edu
IN, Joe Ikely jikley@purdue.edu
WI, Rodrigo Werle rwerle@wisc.edu

Still to figure out from Dan R.'s list:
Mi - Christie sort (??? Christie Sprague sprague1@msu.edu)
KT, - Amet Greg (??? Greg Armel garmel@utk.edu)
tx - peter douchere (??? Peter Dotray p-dotray@tamu.edu)
Va - Mike cleaner (??? Michael Flessner flessner@vt.edu)
Pa- ? (??? Dwight Lingenfelter dxl18@psu.edu)

Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 8/6/2018 10:37:25 PM
To: Baris, Reuben [Baris.Reuben@epa.gov]
Subject: Re: List help

NE - Amit Jhala

Sent from my iPhone

On Aug 6, 2018, at 4:12 PM, Baris, Reuben <Baris.Reuben@epa.gov> wrote:

> Hey Jason,
> Can you help fill in the gaps from Dan's chicken scratch? Thank you.
>
> IA, Bob Hartzler hartzler@iastate.edu
> MS, Jason Bond jason.bond@msstate.edu
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> SD, Sharon Clay sharon.clay@sdstate.edu
> KS, Dallas Peterson dpeterso@ksu.edu
> OK, Todd Baughman todd.baughman@okstate.edu
> LA, Daniel Stephenson DStephenson@agcenter.lsu.edu
> TX, Scott Nolte scott.nolte@tamu.edu
> AL, Steve Li xzl0004@auburn.edu
> GA, Stanley Culpepper stanley@uga.edu
> SC, Mike Marshall marsha3@clemson.edu
> TN, Larry Steckel lsteckel@tennessee.edu
> IL, Aaron Hager hager@illinois.edu
> DE, Mark VanGessel mjv@udel.edu
> IN, Bill Johnson wgj@purdue.edu
> IN, Joe Ikely jikley@purdue.edu
> WI, Rodrigo Werle rwerle@wisc.edu
>
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> Va - Mike cleaner (??? Michael Flessner flessner@vt.edu)
> Pa- ? (??? Dwight Lingenfelter dxl18@psu.edu)

Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 8/6/2018 10:36:27 PM
To: Baris, Reuben [Baris.Reuben@epa.gov]
Subject: Re: List help

All of these appear correct.

Jason

Sent from my iPhone

On Aug 6, 2018, at 4:12 PM, Baris, Reuben <Baris.Reuben@epa.gov> wrote:

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>
> IA, Bob Hartzler hartzler@iastate.edu
> MS, Jason Bond jason.bond@msstate.edu
> OH, Mark Loux loux.1@osu.edu
> MN, Jeff Gonsulus gunso001@umn.edu
> ND, Tom Peters Thomas.J.Peters@ndsu.edu
> SD, Sharon Clay sharon.clay@sdstate.edu
> KS, Dallas Peterson dpeterso@ksu.edu
> OK, Todd Baughman todd.baughman@okstate.edu
> LA, Daniel Stephenson DStephenson@agcenter.lsu.edu
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> AL, Steve Li xzl0004@auburn.edu
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> SC, Mike Marshall marsha3@clemson.edu
> TN, Larry Steckel lsteckel@tennessee.edu
> IL, Aaron Hager hager@illinois.edu
> DE, Mark VanGessel mjv@udel.edu
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> Va - Mike cleaner (??? Michael Flessner flessner@vt.edu)
> Pa- ? (??? Dwight Lingenfelter dxl18@psu.edu)

Message

From: Loux, Mark [loux.1@osu.edu]
Sent: 1/16/2018 8:42:37 PM
To: Amy Bamber [aapco.sfireg@gmail.com]
CC: Dallas Peterson [dpeterso@ksu.edu]; , 'Greg Kruger' [greg.kruger@unl.edu]; , ALFRED Culpepper [stanley@uga.edu]; , Aaron Hager [hager@illinois.edu]; Ambrosino, Helene [Ambrosino.Helene@epa.gov]; , Anderson, Meaghan J [EXTAG] [mjanders@iastate.edu]; Baris, Reuben [Baris.Reuben@epa.gov]; Beck, Nancy [Beck.Nancy@epa.gov]; Becker, Jonathan [Becker.Jonathan@epa.gov]; Bennett, Tate [Bennett.Tate@epa.gov]; Berckes, Nicole [Berckes.Nicole@epa.gov]; , Bill Johnson [wgj@purdue.edu]; , Bob Hartzler [hartzler@iastate.edu]; , Bond, Jason [JBond@drec.msstate.edu]; Chism, William [Chism.Bill@epa.gov]; Corbin, Mark [Corbin.Mark@epa.gov]; Cory, Preston (Katherine) [Cory.Preston@epa.gov]; DCRoomPYS7731E/Potomac-Yard-One [DCRoomPYS7731E@epa.gov]; , Dallas Peterson [dpeterso@oznet.ksu.edu]; , Giguere, Cary (Cary.Giguere@vermont.gov) [Cary.Giguere@vermont.gov]; Goodis, Michael [Goodis.Michael@epa.gov]; Green, Jamie [Green.Jamie@epa.gov]; Group Audio-Teleconf [Audio-Teleconf@epa.gov]; Jakob, Avivah [Jakob.Avivah@epa.gov]; , Jason Norsworthy [jnorswor@uark.edu]; Keigwin, Richard [Keigwin.Richard@epa.gov]; Kenny, Daniel [Kenny.Dan@epa.gov]; , Larry Steckel [lsteckel@utk.edu]; , Lee VanWychen [Lee.VanWychen@wssa.net]; Lott, Don [Lott.Don@epa.gov]; Meadows, Sarah [Meadows.Sarah@epa.gov]; , Mike Barrett [mbarrett@uky.edu]; , Mike Owen [mdowen@iastate.edu]; Miller, Wynne [Miller.Wynne@epa.gov]; Montague, Kathryn V. [Montague.Kathryn@epa.gov]; , Paluch, Gretchen [Gretchen.Paluch@iowaagriculture.gov]; Pease, Anita [Pease.Anita@epa.gov]; Rosenblatt, Daniel [Rosenblatt.Dan@epa.gov]; Rowland, Grant [Rowland.Grant@epa.gov]; , Schroeder, Jill [Jill.Schroeder@ars.usda.gov]; Sisco, Debby [Sisco.Debby@epa.gov]; Strauss, Linda [Strauss.Linda@epa.gov]; , Tom Barber [tbarber@uaex.edu]; Trivedi, Adrienne [Trivedi.Adrienne@epa.gov]; Wormell, Lance [Wormell.Lance@epa.gov]; , bradleyke@misourri.edu [bradleyke@misourri.edu]; , bradleyke@missouri.edu [bradleyke@missouri.edu]; , bscott@uaex.edu [bscott@uaex.edu]; , eprostko@uga.edu [eprostko@uga.edu]; , jason.bond@msstate.edu [jason.bond@msstate.edu]; tdrake@clemson.edu; , tmueller@utk.edu [tmueller@utk.edu]; tony.cofer@agi.alabama.gov; Han, Kaythi [Han.Kaythi@epa.gov]
Subject: Re: Dicamba training invite

Darn I thought maybe you were going to teach us how to avoid saying "volatility" so we could be "on the same page" with the companies

Sent from my iPhone

On Jan 16, 2018, at 3:38 PM, Amy Bamber <aapco.sfireg@gmail.com> wrote:

> No problem, thanks!
>
> On Tue, Jan 16, 2018 at 2:42 PM Dallas Peterson <dpeterso@ksu.edu> wrote:
>
>> I apologize for a calendar request that apparently went out to all of you. I don't even know how it happened.
>>
>> Please disregard.
>>
>> Thanks,
>>
>> Dallas
>> --
>> Dallas E. Peterson
>> Professor and Extension Weed Specialist
>> Dept. of Agronomy
>> Kansas State University
>> 785-532-0405
>
> --

Amy Bamber
Executive Secretary
AAPCO-SFIREG
406-431-3176
aapco.org

Message

From: Amy Bamber [aapco.sfireg@gmail.com]
Sent: 1/16/2018 8:38:16 PM
To: Dallas Peterson [dpeterso@ksu.edu]
CC: , 'Greg Kruger' [greg.kruger@unl.edu]; , ALFRED Culpepper [stanley@uga.edu]; , Aaron Hager [hager@illinois.edu]; Ambrosino, Helene [Ambrosino.Helene@epa.gov]; , Anderson, Meaghan J [EXTAG] [mjanders@iastate.edu]; Baris, Reuben [Baris.Reuben@epa.gov]; Beck, Nancy [Beck.Nancy@epa.gov]; Becker, Jonathan [Becker.Jonathan@epa.gov]; Bennett, Tate [Bennett.Tate@epa.gov]; Berckes, Nicole [Berckes.Nicole@epa.gov]; , Bill Johnson [wgj@purdue.edu]; , Bob Hartzler [hartzler@iastate.edu]; , Bond, Jason [JBond@drec.msstate.edu]; Chism, William [Chism.Bill@epa.gov]; Corbin, Mark [Corbin.Mark@epa.gov]; Cory, Preston (Katherine) [Cory.Preston@epa.gov]; DCRoomPYS7731E/Potomac-Yard-One [DCRoomPYS7731E@epa.gov]; , Dallas Peterson [dpeterso@oznet.ksu.edu]; , Giguere, Cary (Cary.Giguere@vermont.gov) [Cary.Giguere@vermont.gov]; Goodis, Michael [Goodis.Michael@epa.gov]; Green, Jamie [Green.Jamie@epa.gov]; Group Audio-Teleconf [Audio-Teleconf@epa.gov]; Jakob, Avivah [Jakob.Avivah@epa.gov]; , Jason Norsworthy [jnorswor@uark.edu]; Keigwin, Richard [Keigwin.Richard@epa.gov]; Kenny, Daniel [Kenny.Dan@epa.gov]; , Larry Steckel [lsteckel@utk.edu]; , Lee VanWychen [Lee.VanWychen@wssa.net]; Lott, Don [Lott.Don@epa.gov]; , Mark Loux [loux.1@osu.edu]; Meadows, Sarah [Meadows.Sarah@epa.gov]; , Mike Barrett [mbarrett@uky.edu]; , Mike Owen [mdowen@iastate.edu]; Miller, Wynne [Miller.Wynne@epa.gov]; Montague, Kathryn V. [Montague.Kathryn@epa.gov]; , Paluch, Gretchen [Gretchen.Paluch@iowaagriculture.gov]; Pease, Anita [Pease.Anita@epa.gov]; Rosenblatt, Daniel [Rosenblatt.Dan@epa.gov]; Rowland, Grant [Rowland.Grant@epa.gov]; , Schroeder, Jill [Jill.Schroeder@ars.usda.gov]; Sisco, Debby [Sisco.Debby@epa.gov]; Strauss, Linda [Strauss.Linda@epa.gov]; , Tom Barber [tbarber@uaex.edu]; Trivedi, Adrienne [Trivedi.Adrienne@epa.gov]; Wormell, Lance [Wormell.Lance@epa.gov]; , bradleyke@misourri.edu [bradleyke@misourri.edu]; , bradleyke@missouri.edu [bradleyke@missouri.edu]; , bscott@uaex.edu [bscott@uaex.edu]; , eprostko@uga.edu [eprostko@uga.edu]; , jason.bond@msstate.edu [jason.bond@msstate.edu]; tdrake@clemson.edu; , tmueller@utk.edu [tmueller@utk.edu]; tony.cofer@agi.alabama.gov; Han, Kaythi [Han.Kaythi@epa.gov]
Subject: Re: Dicamba training invite

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On Tue, Jan 16, 2018 at 2:42 PM Dallas Peterson <dpeterso@ksu.edu> wrote:

> I apologize for a calendar request that apparently went out to all of you. I don't even know how it happened.
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> Please disregard.
>
> Thanks,
>
> Dallas
>
> --
> Dallas E. Peterson
> Professor and Extension Weed Specialist
> Dept. of Agronomy
> Kansas State University
> 785-532-0405

--
Amy Bamber
Executive Secretary
AAPCO-SFIREG
406-431-3176
aapco.org

Message

From: Dallas Peterson [dpeterso@ksu.edu]
Sent: 1/16/2018 7:42:20 PM
To: Han, Kaythi [Han.Kaythi@epa.gov]; tdrake@clemson.edu; Becker, Jonathan [Becker.Jonathan@epa.gov]; , 'Greg Kruger' [greg.kruger@unl.edu]; , Mike Owen [mdowen@iastate.edu]; , bscott@uaex.edu [bscott@uaex.edu]; Corbin, Mark [Corbin.Mark@epa.gov]; , Dallas Peterson [dpeterso@oznet.ksu.edu]; Cory, Preston (Katherine) [Cory.Preston@epa.gov]; Rowland, Grant [Rowland.Grant@epa.gov]; , Giguere, Cary (Cary.Giguere@vermont.gov) [Cary.Giguere@vermont.gov]; Berckes, Nicole [Berckes.Nicole@epa.gov]; , ALFRED Culpepper [stanley@uga.edu]; , eprostko@uga.edu [eprostko@uga.edu]; , Aaron Hager [hager@illinois.edu]; , Mark Loux [loux.1@osu.edu]; Green, Jamie [Green.Jamie@epa.gov]; Rosenblatt, Daniel [Rosenblatt.Dan@epa.gov]; Group Audio-Teleconf [Audio-Teleconf@epa.gov]; , Mike Barrett [mbarrett@uky.edu]; Baris, Reuben [Baris.Reuben@epa.gov]; Beck, Nancy [Beck.Nancy@epa.gov]; Keigwin, Richard [Keigwin.Richard@epa.gov]; Meadows, Sarah [Meadows.Sarah@epa.gov]; , Bond, Jason [JBond@drec.msstate.edu]; , Paluch, Gretchen [Gretchen.Paluch@Iowaagriculture.gov]; , bradleyke@missouri.edu [bradleyke@missouri.edu]; Wormell, Lance [Wormell.Lance@epa.gov]; , Tom Barber [tbarber@uaex.edu]; Bennett, Tate [Bennett.Tate@epa.gov]; , Amy Bamber [aapco.sfireg@gmail.com]; , tmueller@utk.edu [tmueller@utk.edu]; Kenny, Daniel [Kenny.Dan@epa.gov]; DCRoomPYS7731E/Potomac-Yard-One [DCRoomPYS7731E@epa.gov]; Lott, Don [Lott.Don@epa.gov]; Ambrosino, Helene [Ambrosino.Helene@epa.gov]; , Anderson, Meaghan J [EXTAG] [mjanders@iastate.edu]; , Bill Johnson [wgj@purdue.edu]; Jakob, Avivah [Jakob.Avivah@epa.gov]; Chism, William [Chism.Bill@epa.gov]; Miller, Wynne [Miller.Wynne@epa.gov]; Pease, Anita [Pease.Anita@epa.gov]; , Jason Norsworthy [jnorswor@uark.edu]; , Schroeder, Jill [Jill.Schroeder@ARS.USDA.GOV]; , Larry Steckel [lsteckel@utk.edu]; Trivedi, Adrienne [Trivedi.Adrienne@epa.gov]; Strauss, Linda [Strauss.Linda@epa.gov]; Montague, Kathryn V. [Montague.Kathryn@epa.gov]; , Bob Hartzler [hartzler@iastate.edu]; , jason.bond@msstate.edu [jason.bond@msstate.edu]; Sisco, Debby [Sisco.Debby@epa.gov]; , Lee VanWychen [Lee.VanWychen@wssa.net]; , bradleyke@misourri.edu [bradleyke@misourri.edu]; tony.cofer@agi.alabama.gov; Goodis, Michael [Goodis.Michael@epa.gov]
Subject: Dicamba training invite

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Please disregard.

Thanks,

Dallas

--
Dallas E. Peterson
Professor and Extension Weed Specialist
Dept. of Agronomy
Kansas State University
785-532-0405

Message

From: Senseman, Scott [ssensema@utk.edu]
Sent: 5/30/2018 8:44:01 PM
To: Sid Abel [Sidney.W.Abel@aphis.usda.gov]; chad.asmus@basf.com; Phil Banks [marathonag@zianet.com]; Baris, Reuben [Baris.Reuben@epa.gov]; Kevin Bradley [Bradleyke@missouri.edu]; bob.bruss@us.nufarm.com; jbunting@growmark.com; bursiekChristopherE@johndeere.com; Arlene Cotie [arlene.cotie@bayer.com]; Stanley Culpepper [stanley@uga.edu]; Gregory Dahl [gkdahl@landolakes.com]; Jason Ferrell [jferrell@ufl.edu]; Dave.Frederickson@state.mn.us; brad.fritz@ars.usda.gov; rgrant@purdue.edu; hager@illinois.edu; Andrew Hewitt [a.hewitt@uq.edu.au]; Jhugie@wilburellis.com; Kenny, Daniel [Kenny.Dan@epa.gov]; Susan.M.Koehler@aphis.usda.gov; Greg Kruger [gkruger2@unl.edu]; mark.ledson@syngenta.com; rleon@ncsu.edu; dam37@psu.edu; Mueller, Thomas C [tmueller@utk.edu]; BNichols@cottoninc.com; Jason Norsworthy [jnorswor@uark.edu]; Jean Payne [jeanp@ifca.com]; Steve.Pearson@teejet.com; ryan.j.rector@monsanto.com; jreiss@precisionlab.com; Dan Reynolds [dreynolds@pss.msstate.edu]; Rowland, Grant [Rowland.Grant@epa.gov]; jjschleieriii@dow.com; Jill Schroeder [jill.schroeder@ars.usda.gov]; scottde@purdue.edu; Senseman, Scott [ssensema@utk.edu]; David Shaw [DShaw@research.msstate.edu]; wgs@turbodrop.com; ssmith@redgold.com; Steckel, Larry [lsteckel@utk.edu]; Wayne.Steward@pentair.com; Susan.Sun@croda.com; hthistle@fs.fed.us; Lee Van Wychen [Lee.VanWychen@wssa.net]; WardL@helenachemical.com; Jweirich@mfa-inc.com; kwhiting@smithbucklin.com; Bryan G Young [BryanYoung@purdue.edu]; richardz@amvac-chemical.com; Chism, William [Chism.Bill@epa.gov]; Nicholas.Fleitz@pentair.com; J.Herfort@agrotop.com; HertA@helenaagri.com; Keigwin, Richard [Keigwin.Richard@epa.gov]; susie.nichols@agriculture.arkansas.gov; Peck, Charles [Peck.Charles@epa.gov]; Joshua.Stamper@state.mn.us; ty.k.witten@monsanto.com
Subject: Invitation to Comment on Draft Report from WSSA Research Workshop for Managing Dicamba Off-Target Movement

Dear Invitees and Participants,

Once again, I would like to thank all of you for being willing to participate in our April workshop in DC to discuss herbicide off-target movement. I believe that it was a very productive meeting and we hope to have a set of positive outcomes going forward. Our writing committee has done a great deal of work to capture the points made at the meeting and to provide a comprehensive report for your review. We very much would like to keep the review process short and to get feedback from this group in the next 7 days (by June 6, 2018 Close of Business). Upon that deadline, we will be sending it to two WSSA Committees, 1) Formulations, Adjuvants, and Application Technology and 2) Environmental Aspects for their input in the same timeframe. Finally, we will send the edited version to the registrants and ultimately to our webpage for display over the next several weeks.

I am planning to use Google Docs to facilitate the review process. The document can be accessed at this link. We have also created a link to all of the PDF files of the 11 presentations that were made at the Workshop. Any comments that you would like to provide will show up as suggested edits or you can add comments through the "insert" menu. If you have any issues seeing the document, please let me know and I will try another method.

Thank you again for helping us understand the data gaps related to this technology. We will do our best to use this information to the betterment of our producers and scientific discipline.

Sincerely,

Scott SensemanPresident, Weed Science Society of America

Scott A. Senseman
Professor and Department Head
Department of Plant Sciences
2431 Joe Johnson Drive, 252 Ellington Plant Sciences Building
Knoxville, Tennessee 37996

865-974-8033 Office / 865-974-1947 Fax
scottsenseman@tennessee.edu | https://ag.tennessee.edu/plantsciences

UTIA INSTITUTE OF AGRICULTURE
THE UNIVERSITY OF TENNESSEE

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Follow Plant Sciences on Twitter - @utkplsc
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Keep in touch with alumni! Add Plant Sciences to your LinkedIN Profile https://lnkd.in/dANBcuz

Message

From: Scott Senseman (via Google Docs) [ssensema@gmail.com]
Sent: 5/30/2018 8:43:37 PM
To: Baris, Reuben [Baris.Reuben@epa.gov]
CC: Sid Abel [Sidney.W.Abel@aphis.usda.gov]; chad.asmus@basf.com; marathonag@zianet.com; Bradleyke@missouri.edu; jbunting@growmark.com; arlene.cotie@bayer.com; stanley@uga.edu; jferrell@ufl.edu; rgrant@purdue.edu; hager@illinois.edu; a.hewitt@uq.edu.au; Kenny, Daniel [Kenny.Dan@epa.gov]; gkruger2@unl.edu; rleon@ncsu.edu; BNichols@cottoninc.com; jnorswor@uark.edu; jeanp@ifca.com; jreiss@precisionlab.com; dreynolds@pss.msstate.edu; ssensema@utk.edu; DShaw@research.msstate.edu; wgs@turbodrop.com; ssmith@redgold.com; lsteckel@utk.edu; hthistle@fs.fed.us; Lee.VanWychen@wssa.net; Jweirich@mfa-inc.com; Keigwin, Richard [Keigwin.Richard@epa.gov]; Peck, Charles [Peck.Charles@epa.gov]
Subject: Dicamba Report_May 30.docx - Invitation to edit

Scott Senseman has invited you to **edit** the following document:

Dicamba Report_May 30.docx

Dear Invitees and Participants,

Once again, I would like to thank all of you for being willing to participate in our April workshop in DC to discuss herbicide off-target movement. I believe that it was a very productive meeting and we hope to have a set of positive outcomes going forward. Our writing committee has done a great deal of work to capture the points made at the meeting and to provide a comprehensive report for your review. We very much would like to keep the review process short and to get feedback from this group in the next 7 days (by June 6, 2018 Close of Business). Upon that deadline, we will be sending it to two WSSA Committees, 1) Formulations, Adjuvants, and Application Technology and 2) Environmental Aspects for their input in the same timeframe. Finally, we will send the edited version to the registrants and ultimately to our webpage for display over the next several weeks.

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Thank you again for helping us understand the data gaps related to this technology. We will do our best to use this information to the betterment of our producers and scientific discipline.

Sincerely,

Scott SensemanPresident, Weed Science Society of America

Scott A. Senseman
Professor and Department Head
Department of Plant Sciences
2431 Joe Johnson Drive, 252 Ellington Plant Sciences Building
Knoxville, Tennessee 37996

865-974-8033 Office / 865-974-1947 Fax
scottsenseman@tennessee.edu | https://ag.tennessee.edu/plantsciences

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Follow Plant Sciences on Twitter - @utkplsc

Like Plant Sciences on Facebook - utkplsc
Keep in touch with alumni! Add Plant Sciences to your LinkedIN Profile https://lnkd.in/dANBcuz
Open in Docs

Message

From: Scott Senseman (via Google Docs) [ssensema@gmail.com]
Sent: 5/30/2018 8:51:04 PM
To: Baris, Reuben [Baris.Reuben@epa.gov]
CC: chad.asmus@basf.com; marathonag@zianet.com; Bradleyke@missouri.edu; jbunting@growmark.com; arlene.cotie@bayer.com; stanley@uga.edu; rgrant@purdue.edu; hager@illinois.edu; a.hewitt@uq.edu.au; Keigwin, Richard [Keigwin.Richard@epa.gov]; Kenny, Daniel [Kenny.Dan@epa.gov]; gkruger2@unl.edu; BNichols@cottoninc.com; jnorswor@uark.edu; jeanp@ifca.com; Peck, Charles [Peck.Charles@epa.gov]; jreiss@precisionlab.com; dreynolds@pss.msstate.edu; ssensema@utk.edu; ssmith@redgold.com; lsteckel@utk.edu; hthistle@fs.fed.us; Lee.VanWychen@wssa.net; Jweirich@mfa-inc.com; Sid Abel [Sidney.W.Abel@aphis.usda.gov]
Subject: Dicamba Report_May 30.docx - Invitation to comment

Scott Senseman has invited you to **comment on** the following document:

Dicamba Report_May 30.docx

Open in Docs

Message

From: Young, Bryan G [BryanYoung@purdue.edu]
Sent: 1/4/2018 4:35:22 PM
To: Greg Kruger [greg.kruger@unl.edu]; Baris, Reuben [Baris.Reuben@epa.gov]; Barrett, Michael [mbarrett@uky.edu]; Jill Schroeder [jill.schroeder@ars.usda.gov]
CC: tmueller@tennessee.edu; Bradleyke@missouri.edu; Reynolds, Dan [dreynolds@pss.msstate.edu]; ALFRED Culpepper [stanley@uga.edu]; Jason Keith Norsworthy [jnorswor@uark.edu]; Steckel, Larry [lsteckel@utk.edu]; Aaron Hager [hager@illinois.edu]; Zollinger, Richard [r.zollinger@ndsu.edu]; mdowen@iastate.edu; Senseman, Scott [ssensema@utk.edu]
Subject: RE: Meeting at EPA

Greg,

That should work for me.

Bryan

Bryan Young
Professor of Weed Science
Department of Botany and Plant Pathology
Purdue University
1351 Lilly Hall of Life Sciences
915 West State Street
W. Lafayette, IN 47907
Email: BryanYoung@Purdue.edu
Voice: 765.496.1646

-----Original Message-----
From: Greg Kruger [mailto:greg.kruger@unl.edu]
Sent: Wednesday, January 3, 2018 5:24 PM
To: Baris, Reuben <Baris.Reuben@epa.gov>; Barrett, Michael <mbarrett@uky.edu>; Jill Schroeder <jill.schroeder@ars.usda.gov>
Cc: tmueller@tennessee.edu; Bradleyke@missouri.edu; Reynolds, Dan <dreynolds@pss.msstate.edu>; ALFRED Culpepper <stanley@uga.edu>; Young, Bryan G <BryanYoung@purdue.edu>; Jason Keith Norsworthy <jnorswor@uark.edu>; Steckel, Larry <lsteckel@utk.edu>; Aaron Hager <hager@illinois.edu>; Zollinger, Richard <r.zollinger@ndsu.edu>; mdowen@iastate.edu; Senseman, Scott <ssensema@utk.edu>
Subject: RE: Meeting at EPA

All,

I hope 2017 turned out well for you and 2018 is off and running! Since WSSA is just around the corner and since it is Crystal City this year, we want to take full advantage of the proximity to EPA. I have been working with Reuben Baris at EPA to set up a meeting to discuss off-target movement of dicamba. We know that there is never going to be a convenient time for everybody, but we have settled on trying to do the meeting on Monday January 29th at 1:30 pm. We will keep the meeting short (1 hour) at EPA headquarters. This means that we will have about a 15 minute walk from the hotel or I can see if we can get a shuttle arranged if enough people are interested in going that route. I would like to get the group walking towards EPA headquarters at 12:45 because it will take a little time to get through security once we get there. The main purpose of the meeting will be to give you guys a chance to share with EPA what questions you are asking (of the growers and of industry), what you are working on, and what you are finding related to off-target movement of dicamba. It is our hope that it will then lead into a discussion on what are the implications for 2018. If you are both willing and able to make the meeting, please let me know by next Wednesday so that I can have a head count.

Thanks,

Greg

Message

From: Steckel, Larry [lsteckel@utk.edu]
Sent: 1/4/2018 1:44:27 PM
To: Greg Kruger [greg.kruger@unl.edu]; Baris, Reuben [Baris.Reuben@epa.gov]; Barrett, Michael [mbarrett@uky.edu]; Jill Schroeder [jill.schroeder@ars.usda.gov]
CC: Mueller, Thomas C [tmueller@utk.edu]; Bradleyke@missouri.edu; Reynolds, Dan [dreynolds@pss.msstate.edu]; ALFRED Culpepper [stanley@uga.edu]; Bryan Young (BryanYoung@purdue.edu) [BryanYoung@purdue.edu]; Jason Keith Norsworthy [jnorswor@uark.edu]; Aaron Hager [hager@illinois.edu]; Zollinger, Richard [r.zollinger@ndsu.edu]; mdowen@iastate.edu; Senseman, Scott [ssensema@utk.edu]
Subject: RE: Meeting at EPA

Greg

I think I can be there...thanks

-----Original Message-----
From: Greg Kruger [mailto:greg.kruger@unl.edu]
Sent: Wednesday, January 03, 2018 4:24 PM
To: Baris, Reuben <Baris.Reuben@epa.gov>; Barrett, Michael <mbarrett@uky.edu>; Jill Schroeder <jill.schroeder@ars.usda.gov>
Cc: Mueller, Thomas C <tmueller@utk.edu>; Bradleyke@missouri.edu; Reynolds, Dan <dreynolds@pss.msstate.edu>; ALFRED Culpepper <stanley@uga.edu>; Bryan Young (BryanYoung@purdue.edu) <BryanYoung@purdue.edu>; Jason Keith Norsworthy <jnorswor@uark.edu>; Steckel, Larry <lsteckel@utk.edu>; Aaron Hager <hager@illinois.edu>; Zollinger, Richard <r.zollinger@ndsu.edu>; mdowen@iastate.edu; Senseman, Scott <ssensema@utk.edu>
Subject: RE: Meeting at EPA

All,

I hope 2017 turned out well for you and 2018 is off and running! Since WSSA is just around the corner and since it is Crystal City this year, we want to take full advantage of the proximity to EPA. I have been working with Reuben Baris at EPA to set up a meeting to discuss off-target movement of dicamba. We know that there is never going to be a convenient time for everybody, but we have settled on trying to do the meeting on Monday January 29th at 1:30 pm. We will keep the meeting short (1 hour) at EPA headquarters. This means that we will have about a 15 minute walk from the hotel or I can see if we can get a shuttle arranged if enough people are interested in going that route. I would like to get the group walking towards EPA headquarters at 12:45 because it will take a little time to get through security once we get there. The main purpose of the meeting will be to give you guys a chance to share with EPA what questions you are asking (of the growers and of industry), what you are working on, and what you are finding related to off-target movement of dicamba. It is our hope that it will then lead into a discussion on what are the implications for 2018. If you are both willing and able to make the meeting, please let me know by next Wednesday so that I can have a head count.

Thanks,

Greg

Message

From: Schroeder, Jill [Jill.Schroeder@ARS.USDA.GOV]
Sent: 1/4/2018 1:25:22 PM
To: Greg Kruger [greg.kruger@unl.edu]; Baris, Reuben [Baris.Reuben@epa.gov]; Barrett, Michael [mbarrett@uky.edu]
CC: tmueller@tennessee.edu; Bradleyke@missouri.edu; Reynolds, Dan [dreynolds@pss.msstate.edu]; ALFRED Culpepper [stanley@uga.edu]; Bryan Young (BryanYoung@purdue.edu) [BryanYoung@purdue.edu]; Jason Keith Norsworthy [jnorswor@uark.edu]; Steckel, Larry [lsteckel@utk.edu]; Aaron Hager [hager@illinois.edu]; Zollinger, Richard [r.zollinger@ndsu.edu]; mdowen@iastate.edu; Senseman, Scott [ssensema@utk.edu]
Subject: RE: Meeting at EPA

I should be able to be there as well. Jill

-----Original Message-----
From: Greg Kruger [mailto:greg.kruger@unl.edu]
Sent: Wednesday, January 03, 2018 5:24 PM
To: Baris, Reuben <Baris.Reuben@epa.gov>; Barrett, Michael <mbarrett@uky.edu>; Schroeder, Jill <Jill.Schroeder@ARS.USDA.GOV>
Cc: tmueller@tennessee.edu; Bradleyke@missouri.edu; Reynolds, Dan <dreynolds@pss.msstate.edu>; ALFRED Culpepper <stanley@uga.edu>; Bryan Young (BryanYoung@purdue.edu) <BryanYoung@purdue.edu>; Jason Keith Norsworthy <jnorswor@uark.edu>; Steckel, Larry <lsteckel@utk.edu>; Aaron Hager <hager@illinois.edu>; Zollinger, Richard <r.zollinger@ndsu.edu>; mdowen@iastate.edu; Senseman, Scott <ssensema@utk.edu>
Subject: RE: Meeting at EPA

All,

I hope 2017 turned out well for you and 2018 is off and running! Since WSSA is just around the corner and since it is Crystal City this year, we want to take full advantage of the proximity to EPA. I have been working with Reuben Baris at EPA to set up a meeting to discuss off-target movement of dicamba. We know that there is never going to be a convenient time for everybody, but we have settled on trying to do the meeting on Monday January 29th at 1:30 pm. We will keep the meeting short (1 hour) at EPA headquarters. This means that we will have about a 15 minute walk from the hotel or I can see if we can get a shuttle arranged if enough people are interested in going that route. I would like to get the group walking towards EPA headquarters at 12:45 because it will take a little time to get through security once we get there. The main purpose of the meeting will be to give you guys a chance to share with EPA what questions you are asking (of the growers and of industry), what you are working on, and what you are finding related to off-target movement of dicamba. It is our hope that it will then lead into a discussion on what are the implications for 2018. If you are both willing and able to make the meeting, please let me know by next Wednesday so that I can have a head count.

Thanks,

Greg

Message

From: Barrett, Michael [mbarrett@uky.edu]
Sent: 1/3/2018 11:31:45 PM
To: Greg Kruger [greg.kruger@unl.edu]; Baris, Reuben [Baris.Reuben@epa.gov]; Jill Schroeder [jill.schroeder@ars.usda.gov]
CC: tmueller@tennessee.edu; Bradleyke@missouri.edu; Reynolds, Dan [dreynolds@pss.msstate.edu]; ALFRED Culpepper [stanley@uga.edu]; Bryan Young (BryanYoung@purdue.edu) [BryanYoung@purdue.edu]; Jason Keith Norsworthy [jnorswor@uark.edu]; Steckel, Larry [lsteckel@utk.edu]; Aaron Hager [hager@illinois.edu]; Zollinger, Richard [r.zollinger@ndsu.edu]; mdowen@iastate.edu; Senseman, Scott [ssensema@utk.edu]
Subject: Re: Meeting at EPA

Greg - I should be able to make it. Mike

Michael Barrett
Department of Plant and Soil Sciences
University of Kentucky
105 Plant Science Building
Lexington, KY 40546-0312
859-218-0712
FAX 859-257-2185

From: Greg Kruger <greg.kruger@unl.edu>
Sent: Wednesday, January 3, 2018 5:23 PM
To: Baris, Reuben; Barrett, Michael; Jill Schroeder
Cc: tmueller@tennessee.edu; Bradleyke@missouri.edu; Reynolds, Dan; ALFRED Culpepper; Bryan Young (BryanYoung@purdue.edu); Jason Keith Norsworthy; Steckel, Larry; Aaron Hager; Zollinger, Richard; mdowen@iastate.edu; Senseman, Scott
Subject: RE: Meeting at EPA

All,

I hope 2017 turned out well for you and 2018 is off and running! Since WSSA is just around the corner and since it is Crystal City this year, we want to take full advantage of the proximity to EPA. I have been working with Reuben Baris at EPA to set up a meeting to discuss off-target movement of dicamba. We know that there is never going to be a convenient time for everybody, but we have settled on trying to do the meeting on Monday January 29th at 1:30 pm. We will keep the meeting short (1 hour) at EPA headquarters. This means that we will have about a 15 minute walk from the hotel or I can see if we can get a shuttle arranged if enough people are interested in going that route. I would like to get the group walking towards EPA headquarters at 12:45 because it will take a little time to get through security once we get there. The main purpose of the meeting will be to give you guys a chance to share with EPA what questions you are asking (of the growers and of industry), what you are working on, and what you are finding related to off-target movement of dicamba. It is our hope that it will then lead into a discussion on what are the implications for 2018. If you are both willing and able to make the meeting, please let me know by next Wednesday so that I can have a head count.

Thanks,

Greg

Message

From: Greg Kruger [greg.kruger@unl.edu]
Sent: 1/3/2018 10:23:32 PM
To: Baris, Reuben [Baris.Reuben@epa.gov]; Barrett, Michael [mbarrett@uky.edu]; Jill Schroeder [jill.schroeder@ars.usda.gov]
CC: tmueller@tennessee.edu; Bradleyke@missouri.edu; Reynolds, Dan [dreynolds@pss.msstate.edu]; ALFRED Culpepper [stanley@uga.edu]; Bryan Young (BryanYoung@purdue.edu) [BryanYoung@purdue.edu]; Jason Keith Norsworthy [jnorswor@uark.edu]; Steckel, Larry [lsteckel@utk.edu]; Aaron Hager [hager@illinois.edu]; Zollinger, Richard [r.zollinger@ndsu.edu]; mdowen@iastate.edu; Senseman, Scott [ssensema@utk.edu]
Subject: RE: Meeting at EPA

All,

I hope 2017 turned out well for you and 2018 is off and running! Since WSSA is just around the corner and since it is Crystal City this year, we want to take full advantage of the proximity to EPA. I have been working with Reuben Baris at EPA to set up a meeting to discuss off-target movement of dicamba. We know that there is never going to be a convenient time for everybody, but we have settled on trying to do the meeting on Monday January 29th at 1:30 pm. We will keep the meeting short (1 hour) at EPA headquarters. This means that we will have about a 15 minute walk from the hotel or I can see if we can get a shuttle arranged if enough people are interested in going that route. I would like to get the group walking towards EPA headquarters at 12:45 because it will take a little time to get through security once we get there. The main purpose of the meeting will be to give you guys a chance to share with EPA what questions you are asking (of the growers and of industry), what you are working on, and what you are finding related to off-target movement of dicamba. It is our hope that it will then lead into a discussion on what are the implications for 2018. If you are both willing and able to make the meeting, please let me know by next Wednesday so that I can have a head count.

Thanks,

Greg

Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 9/13/2018 6:30:29 PM
To: Baris, Reuben [Baris.Reuben@epa.gov]
Subject: RE: formal request
Attachments: EPA Proctor slides (PDF).pdf; Monsanto large drift Proctor data_.xlsx; Proctor_Dicamba_Weather_CR300Series_TableOUT.xlsx

Reuben,

Attached please find the assessments collected from the large-plot trial that I conducted in conjunction with Monsanto at Proctor, AR. Dr. Ashley Brown from MS State University is analyzing the air sample data collected from this trial. I have attached some slides that should help explain what was observed at this location. Let me know if you need anything else or have questions about the trial.

Regards,
Jason

Jason Norsworthy, PhD
Professor and Elms Farming Chair of Weed Science
1366 West Altheimer Dr.
Fayetteville, AR 72704
Tel: 479-575-8740
Mob: 479-313-1265

From: Baris, Reuben <Baris.Reuben@epa.gov>
Sent: Thursday, September 13, 2018 11:27 AM
To: Jason Keith Norsworthy <jnorswor@uark.edu>
Subject: formal request

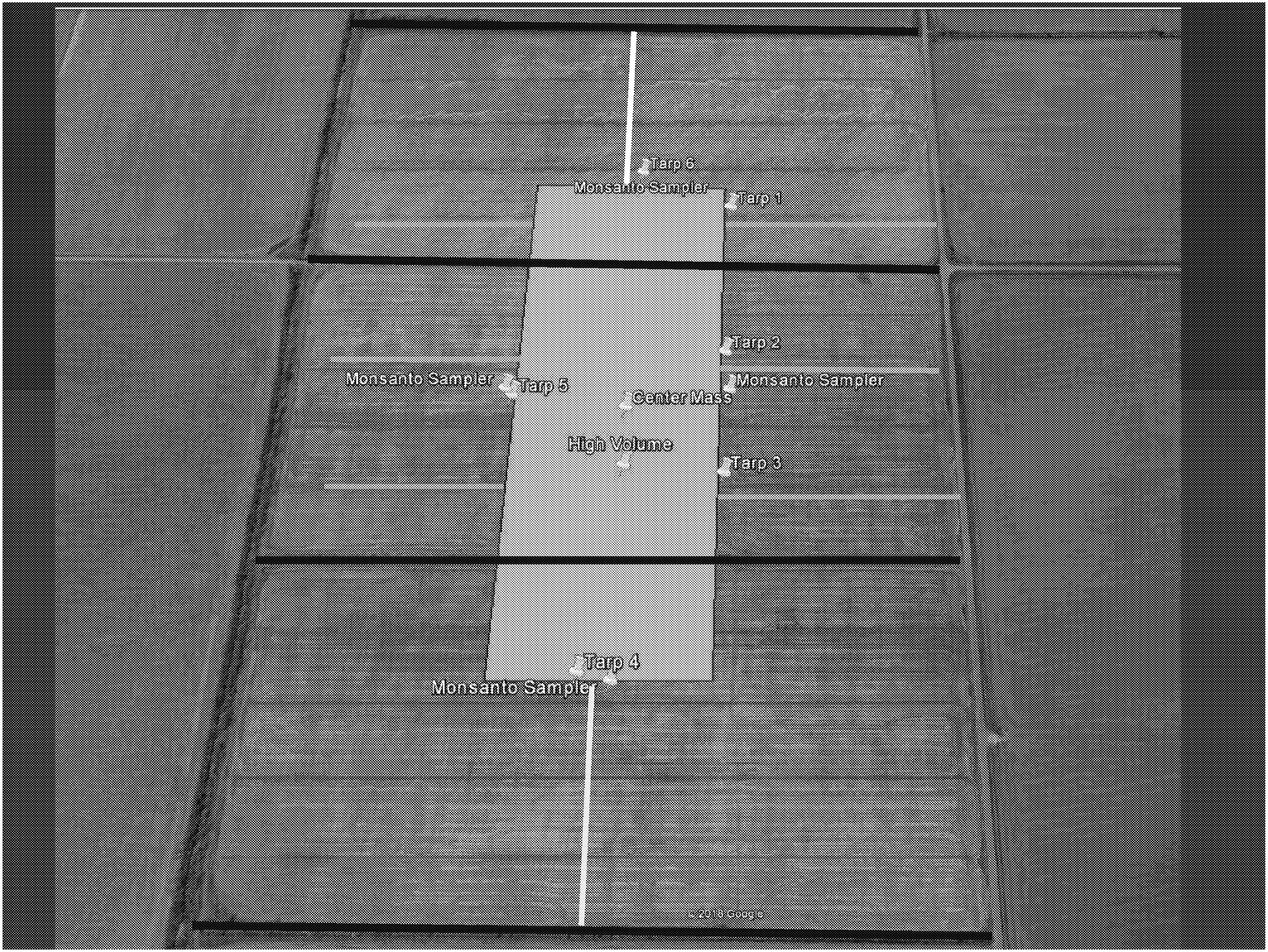
Hey Jason,
This is the formal request, if you're willing, to share the data from your Proctor, AR study on the 240 acre, 80 acre block study.

Happy to discuss more by phone if necessary to talk about mechanisms for sharing with EPA.
Reuben

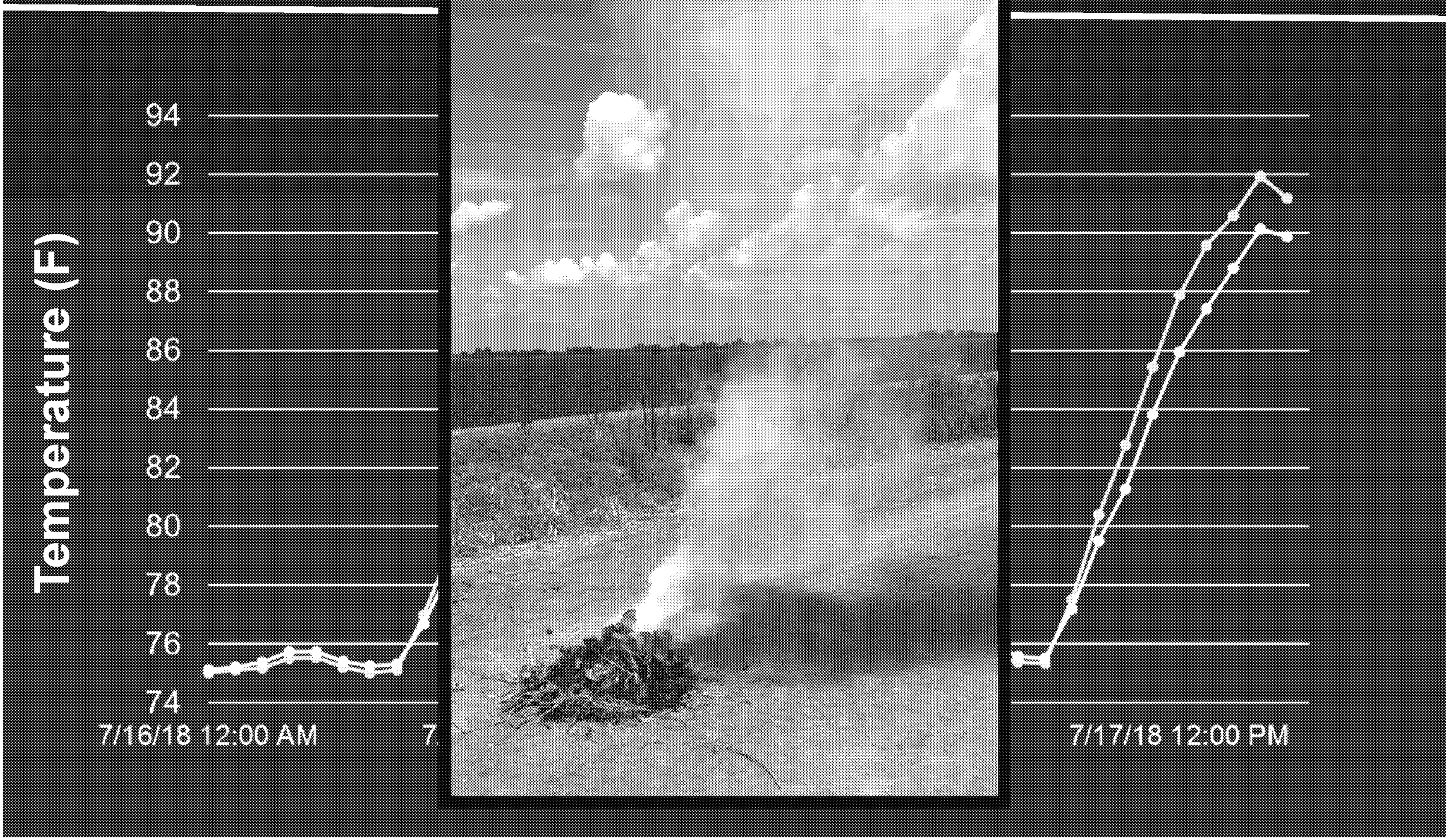
REUBEN BARIS | PRODUCT MANAGER, TEAM 25 | HERBICIDE BRANCH
U.S. ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF PESTICIDE PROGRAMS | (703) 305-7356

From July 9 at 1:00 PM – July 16 at 2:58 PM
No sustained wind speed above 3 mph for at least 1 hour

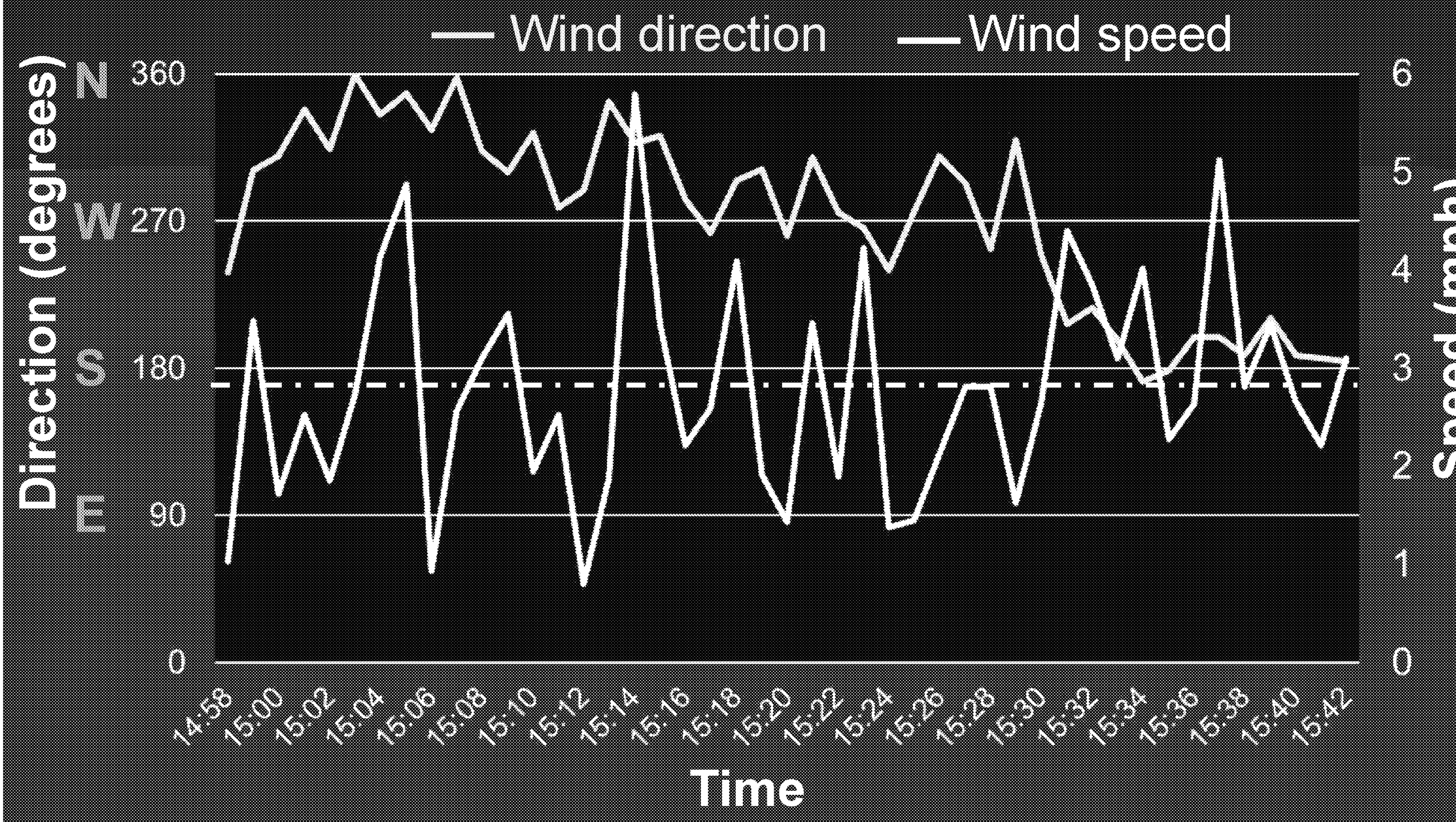
Application made at 2:58 PM on July 16


Tarp 6
Monsanto Sampler
Tarp 1
Tarp 2
Monsanto Sampler
Tarp 5
Monsanto Sampler
Center Mass
High Volume
Tarp 3
Tarp 4
Monsanto Sampler
© 2018 Google

Temperature During and After Application

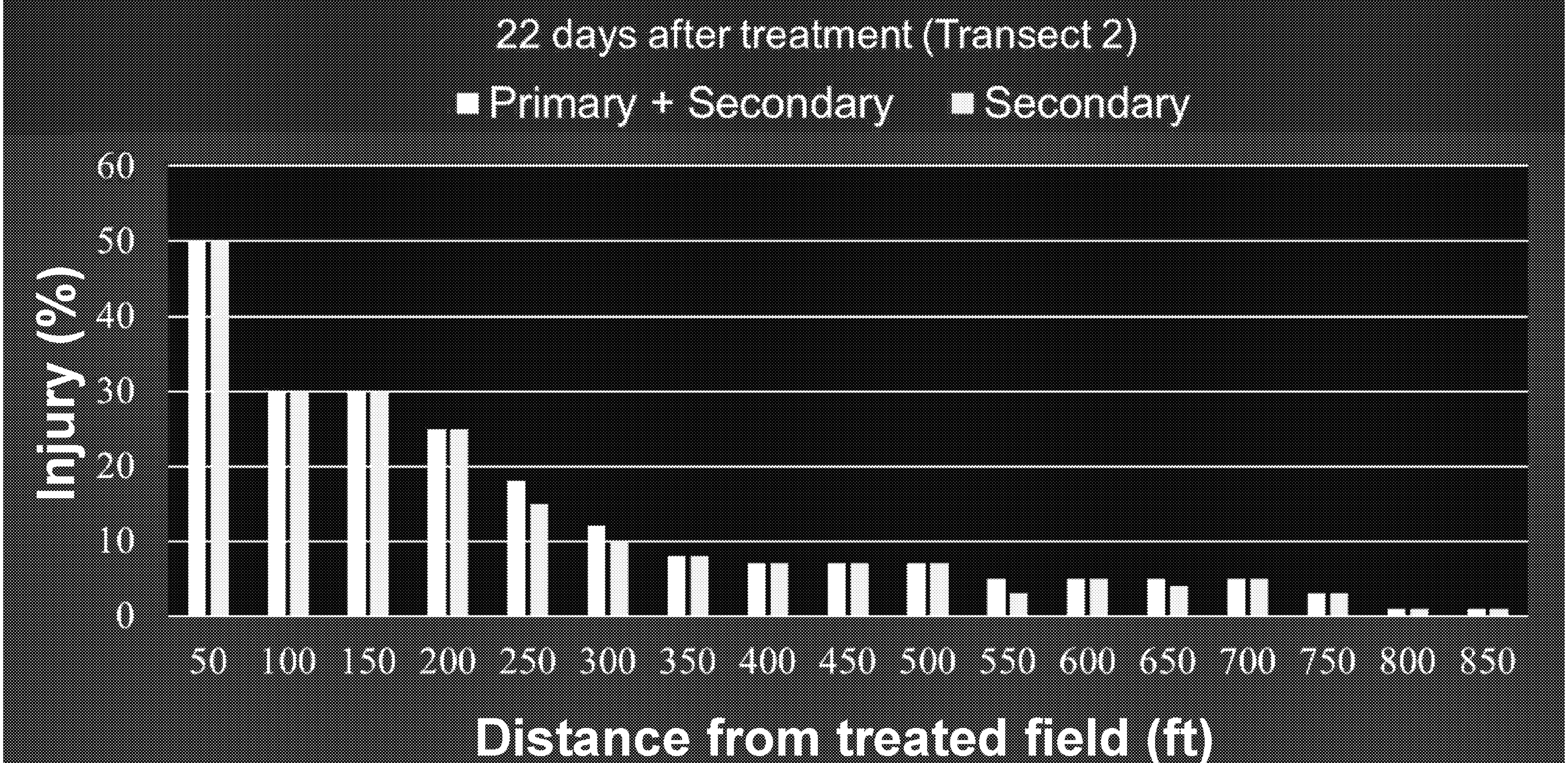


Wind Direction and Speed During Application



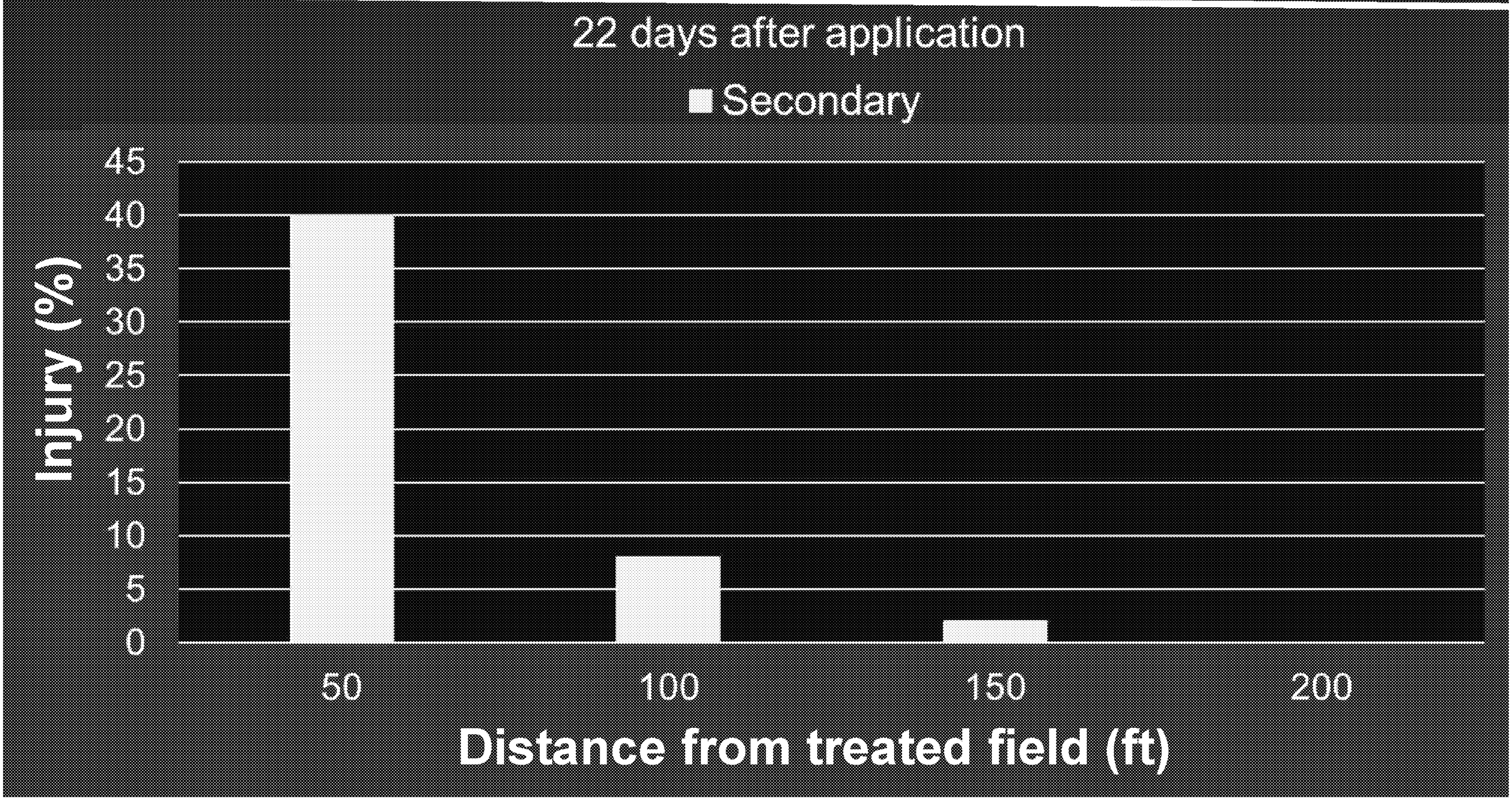

Tarp Covered Soybean Outside Treated Area
Not covered
Covered

Contribution of Secondary Movement to Overall Soybean Injury

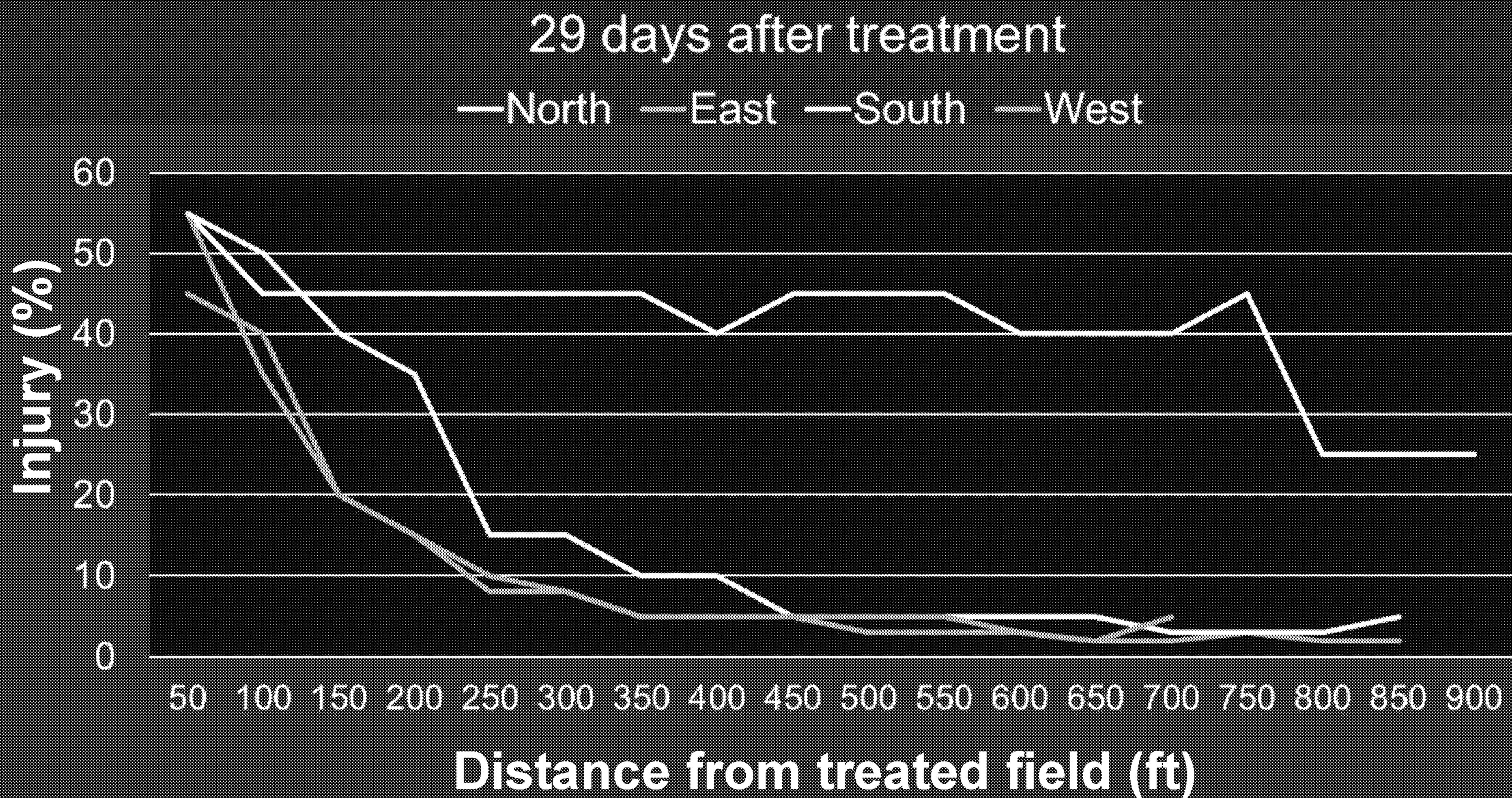


Soybean Injury Caused by Secondary Movement

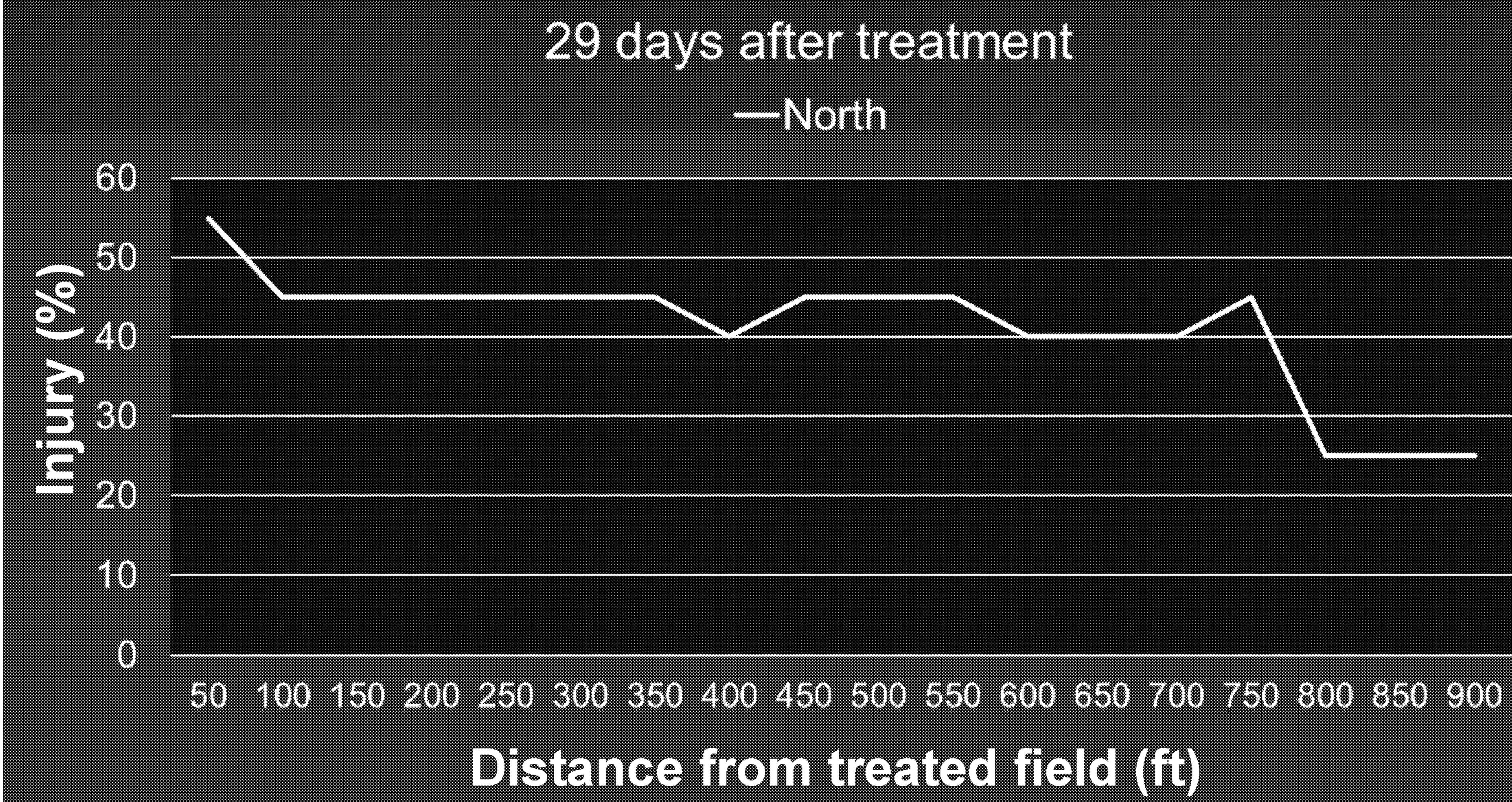
(West Transect 2)



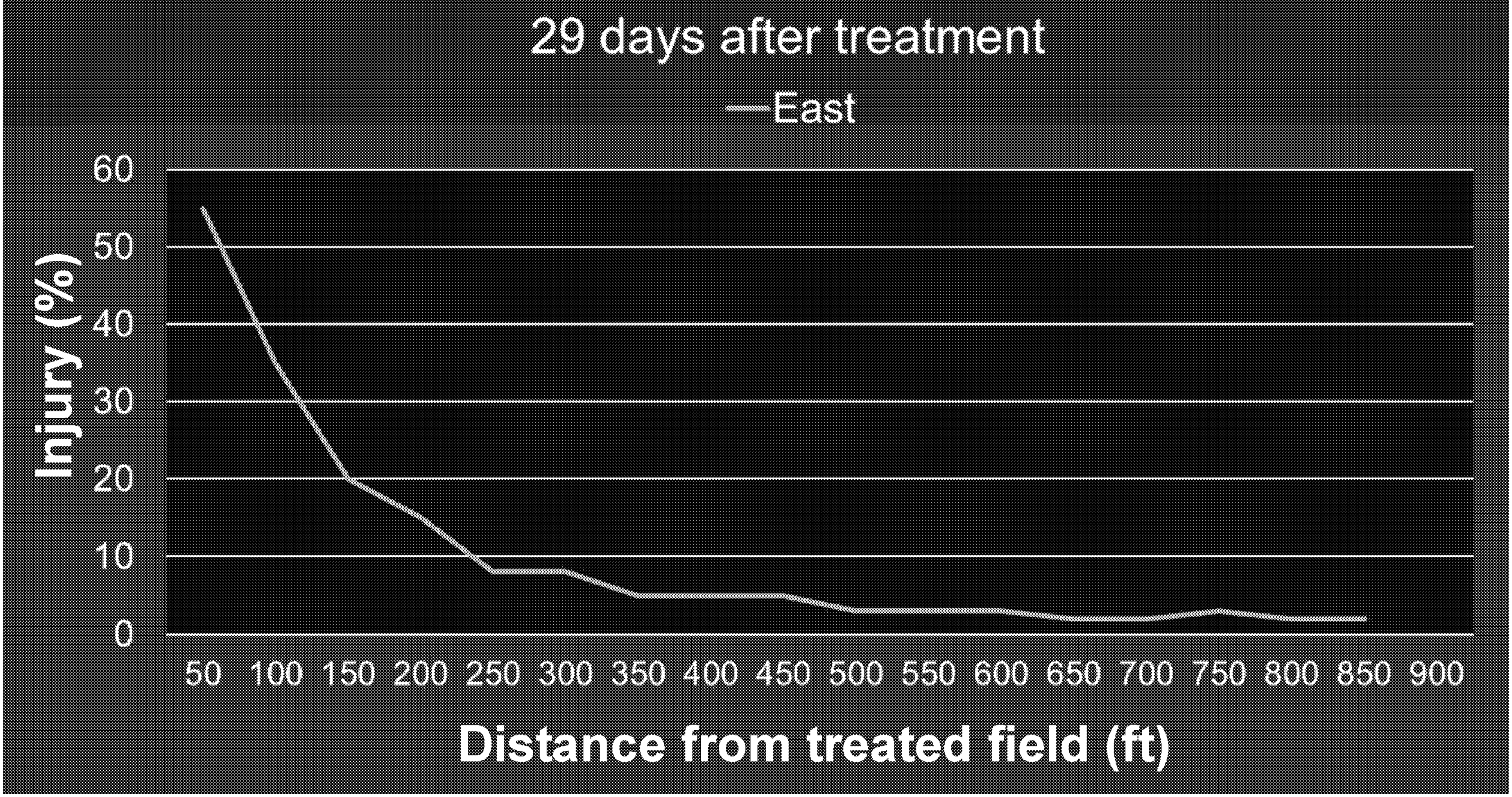
Injury to Soybean on Each Side of Treated Field



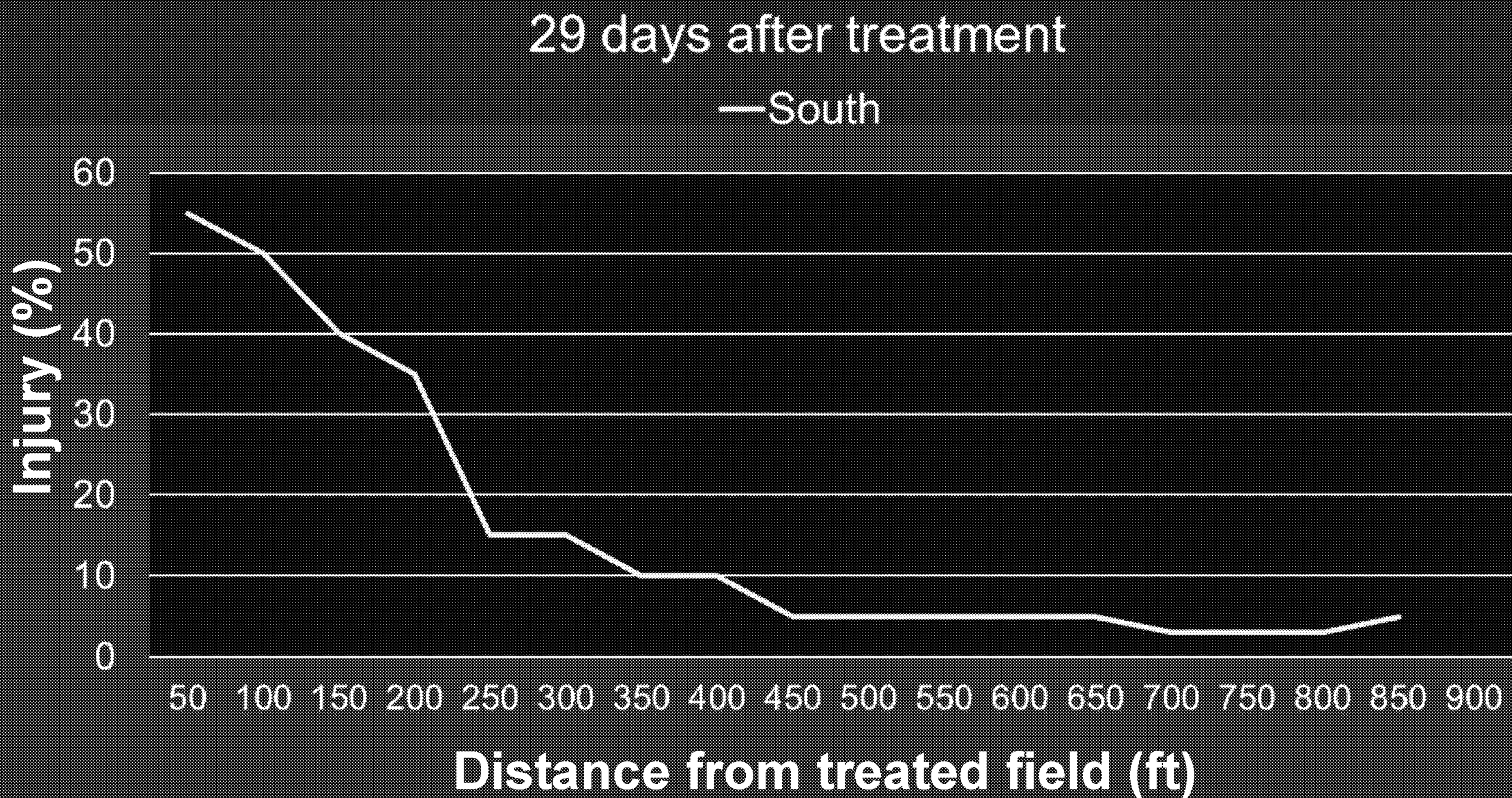
Injury to Soybean on North Side of Treated Field



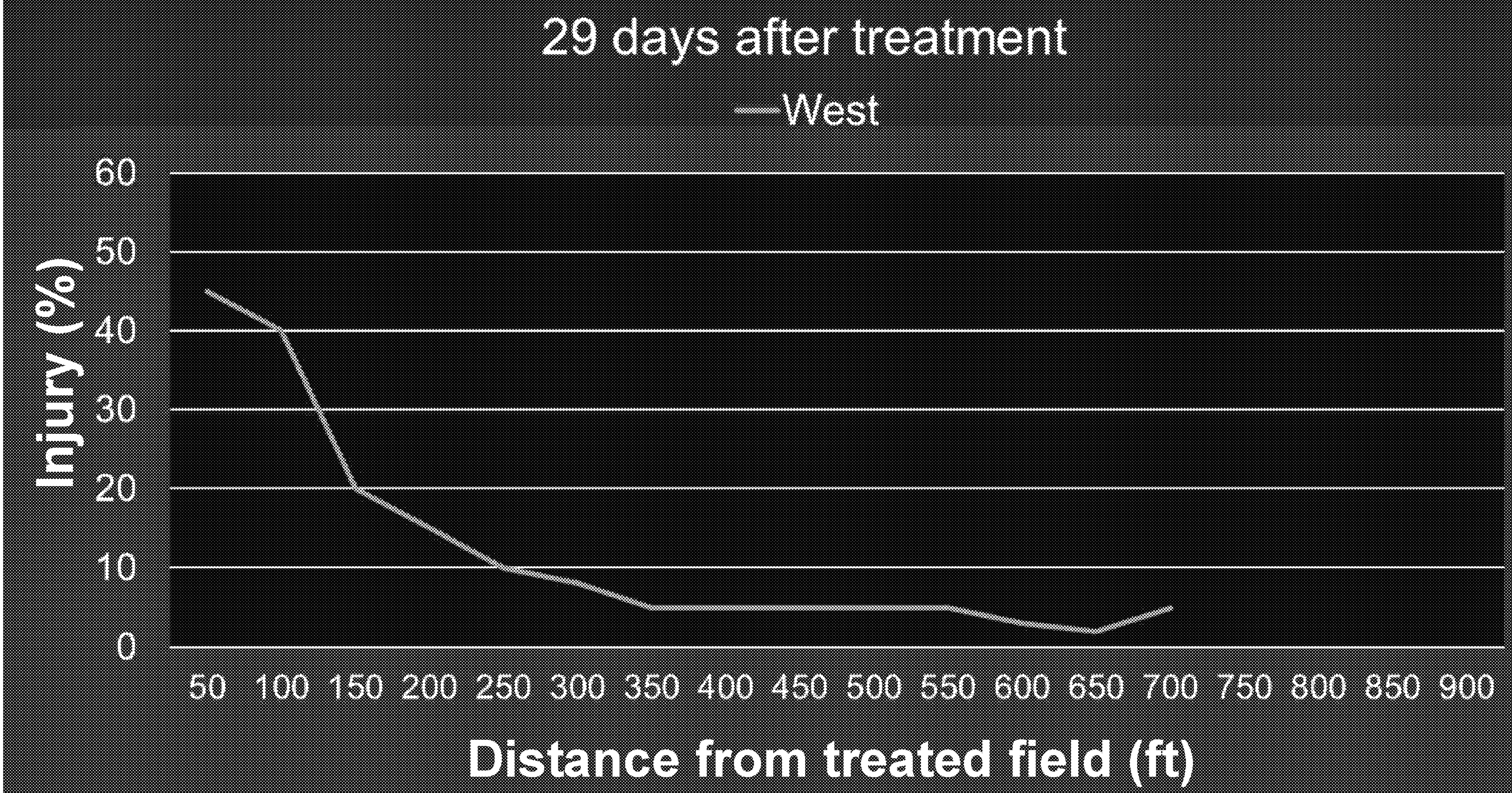
Injury to Soybean on East of Treated Field

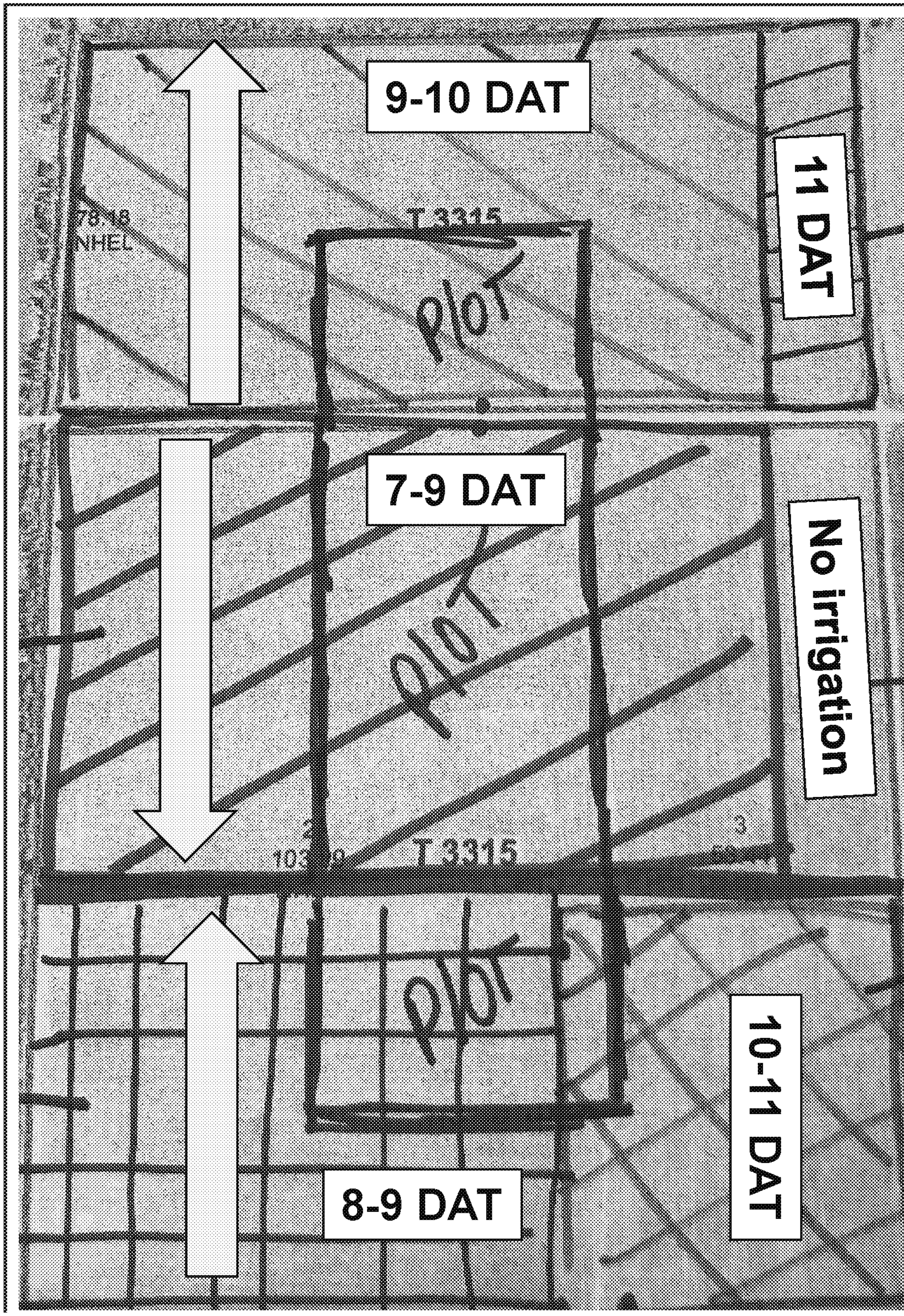


Injury to Soybean on South Side of Treated Field



Injury to Soybean on West Side of Treated Field

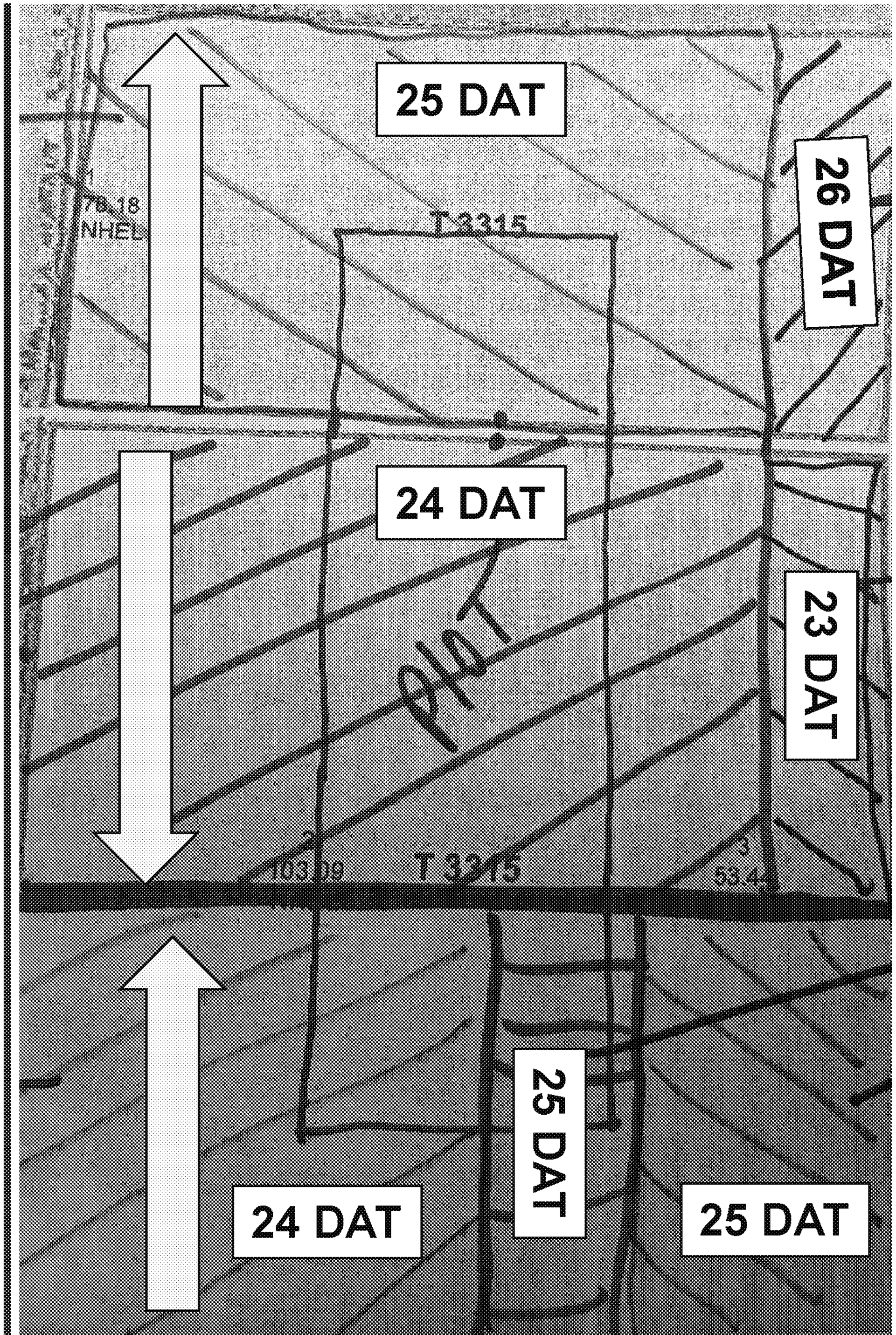




Irrigation Schedule

Plot sprayed July 16 (2:58 – 3:42 PM)

Entire field sprayed July 23 (7 DAT)

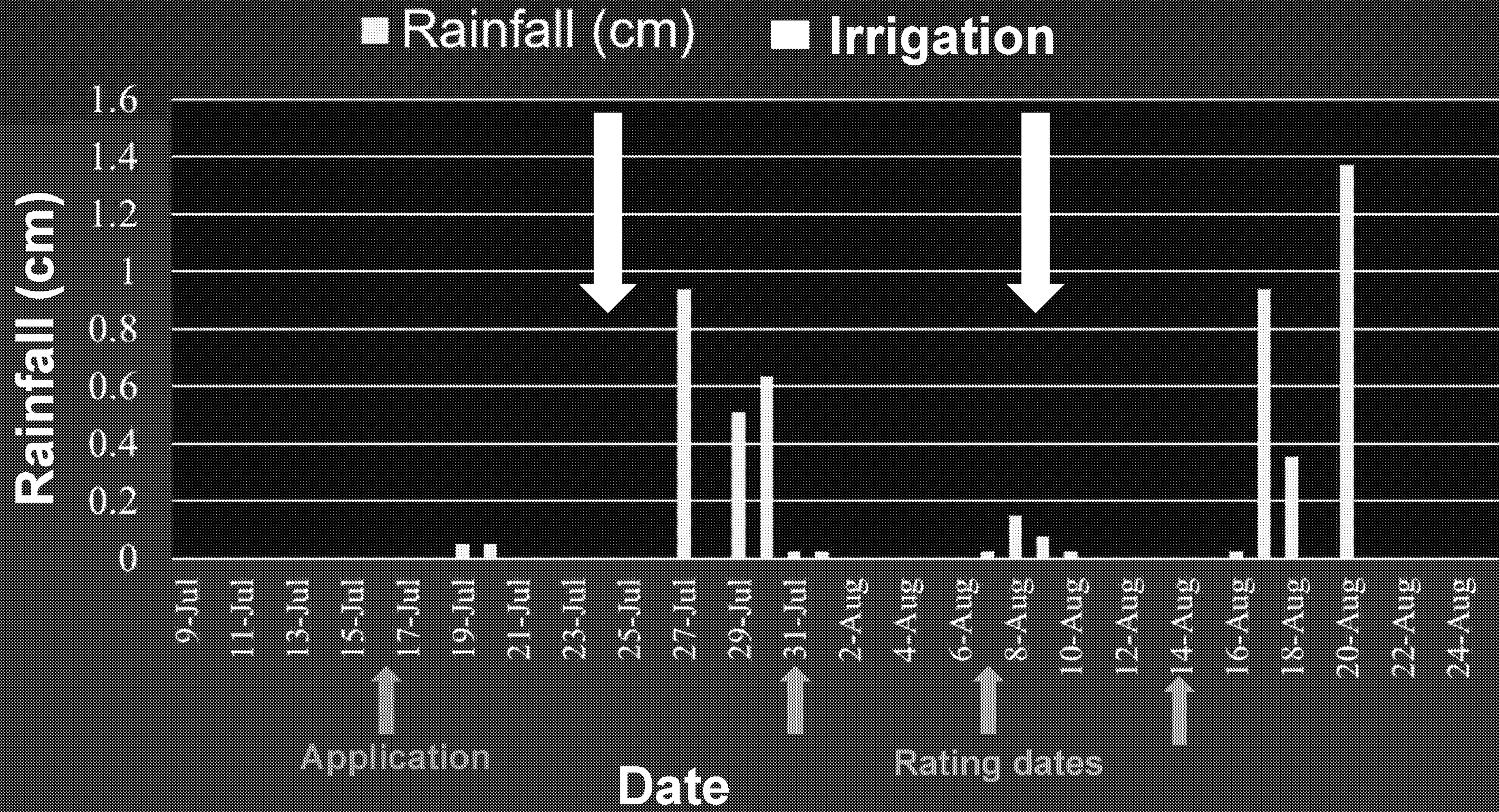


Irrigation Schedule

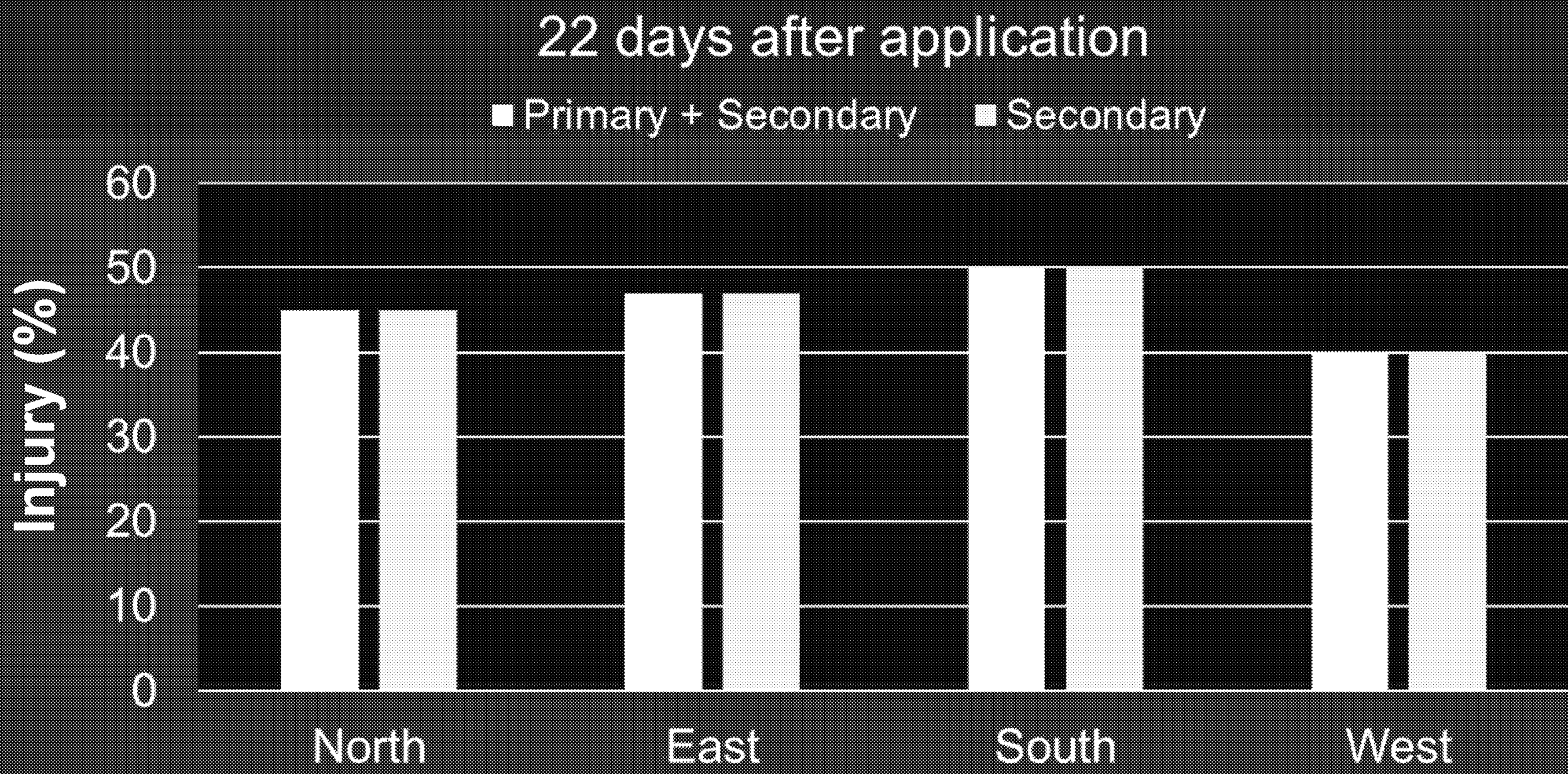
Plot sprayed July 16 (2:58 – 3:42 PM)

Entire field sprayed July 23 (7 DAT)

Rainfall and Irrigation



Injury to Soybean Adjacent to and Beneath Tarps



Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 9/13/2018 2:59:02 PM
To: Baris, Reuben [Baris.Reuben@epa.gov]
Subject: RE: PI's for various studies

See below response.

From: Baris, Reuben <Baris.Reuben@epa.gov>
Sent: Thursday, September 13, 2018 9:09 AM
To: Jason Keith Norsworthy <jnorswor@uark.edu>
Subject: PI's for various studies

Hey Jason,
Please review the list below and ensure I'm contacting the correct PI's for any data/study requests. Thanks. Reuben

Proctor, AR – Dr. Jason Norsworthy
Indiana – Dr. Bryan Young
Michigan – Dr. Christy Sprague
Nebraska – Dr. Greg Kruger
Wisconsin – Dr. Rodrigo Werle

Other studies/research:
Tennessee – Dr. Larry Steckel (Monsanto conducted the trial, but Dr. Larry Steckel observed the results)
Alabama – Dr. Steve Li

Separate from Monsanto – Dr. Tom Mueller at Tennessee has a wealth of data on XtendiMax
Dr. Kevin Bradley also has some XtendiMax volatility research but not with Monsanto

Message

From: Young, Bryan G [BryanYoung@purdue.edu]
Sent: 10/11/2018 7:14:55 PM
To: Baris, Reuben [Baris.Reuben@epa.gov]
CC: Peck, Charles [Peck.Charles@epa.gov]; Jason Keith Norsworthy [jnorswor@uark.edu]; Rodrigo Werle [rwerle@wisc.edu]; Greg Kruger [greg.kruger@unl.edu]; sprague1@msu.edu; Reynolds, Dan [dreynolds@pss.msstate.edu]
Subject: RE: Large-scale dicamba studies: question RE: tank mixes

Reuben,

Answer #1 - One tankmix at 15 GPA with the following products:
Xtendimax @ 22 oz/A
Roundup PowerMax @ 32 oz/A
Intact DRA @ 0.5% v/v

Answer #2 – No deviations from the protocol shared by Monsanto were implemented.

Best,
Bryan

Bryan Young
Professor of Weed Science
Department of Botany and Plant Pathology
Purdue University
1351 Lilly Hall of Life Sciences
915 West State Street
W. Lafayette, IN 47907
Email: BryanYoung@Purdue.edu
Voice: 765.496.1646

From: Baris, Reuben <Baris.Reuben@epa.gov>
Sent: Thursday, October 11, 2018 2:08 PM
To: Rodrigo Werle <rwerle@wisc.edu>; Young, Bryan G <BryanYoung@purdue.edu>; Greg Kruger <greg.kruger@unl.edu>; sprague1@msu.edu; Reynolds, Dan <dreynolds@pss.msstate.edu>
Cc: Peck, Charles <Peck.Charles@epa.gov>; Jason Keith Norsworthy <jnorswor@uark.edu>
Subject: Large-scale dicamba studies: question RE: tank mixes

Drs. Werle, Young, Kruger, Sprague, Reynolds and Norsworthy:

I hope these are easy questions for you all. If you don't want to cc the whole group on this email, you can respond directly to me.

1) What were the tank mix(es) you used in your study for xtendimax off-target movement?
- specifically, was acetochlor (e.g., warrant or other product) used?

2) Were there were any (notable) deviations that they made to the protocol when conducting the study

Thanks for your quick reply.
Reuben

Reuben Baris | Product Manager, Team 25 | Herbicide Branch
U.S. Environmental Protection Agency, Office of Pesticide Programs | (703) 305-7356

Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 10/11/2018 6:56:22 PM
To: Baris, Reuben [Baris.Reuben@epa.gov]; Rodrigo Werle [rwerle@wisc.edu]; Young, Bryan G [BryanYoung@purdue.edu]; Greg Kruger [greg.kruger@unl.edu]; sprague1@msu.edu; Reynolds, Dan [dreynolds@pss.msstate.edu]
CC: Peck, Charles [Peck.Charles@epa.gov]
Subject: RE: Large-scale dicamba studies: question RE: tank mixes

See responses to be below questions.

From: Baris, Reuben <Baris.Reuben@epa.gov>
Sent: Thursday, October 11, 2018 1:08 PM
To: Rodrigo Werle <rwerle@wisc.edu>; Young, Bryan G <BryanYoung@purdue.edu>; Greg Kruger <greg.kruger@unl.edu>; sprague1@msu.edu; Reynolds, Dan <dreynolds@pss.msstate.edu>
Cc: Peck, Charles <Peck.Charles@epa.gov>; Jason Keith Norsworthy <jnorswor@uark.edu>
Subject: Large-scale dicamba studies: question RE: tank mixes

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1) What were the tank mix(es) you used in your study for xtendimax off-target movement?
- specifically, was acetochlor (e.g., warrant or other product) used?

A Monsanto representative (Freeman) did the mixing for my trial along with grower. They mixed XtendiMax, Roundup PowerMax II, Warrant, and Intact.

2) Were there were any (notable) deviations that they made to the protocol when conducting the study

When you say "they", I assume you are meaning Monsanto. I added some assessments (high volume air samplers and plants covered with buckets) to the field trial as indicated in the data sent to the Agency. Bob Montgomery with Monsanto and I cut tarps to 25 ft length rather than 50 ft for covering soybean plants. This should have had no impact on results. There may be other minor deviations but this is all that comes to mind.

Thanks for your quick reply.
Reuben

REUBEN BARIS | PRODUCT MANAGER, TEAM 25 | HERBICIDE BRANCH
U.S. ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF PESTICIDE PROGRAMS | (703) 305-7356

Message

From: Rodrigo Werle [rwerle@wisc.edu]
Sent: 10/11/2018 6:23:24 PM
To: Baris, Reuben [Baris.Reuben@epa.gov]; Young, Bryan G [BryanYoung@purdue.edu]; Greg Kruger [greg.kruger@unl.edu]; sprague1@msu.edu; Reynolds, Dan [dreynolds@pss.msstate.edu]
CC: Peck, Charles [Peck.Charles@epa.gov]; Jason Keith Norsworthy [jnorswor@uark.edu]
Subject: RE: Large-scale dicamba studies: question RE: tank mixes
Attachments: Application Records_Large Scale Dicamba Drift Trial.docx

Hello Reuben,

Attached you will find the application records for the Wisconsin site. Besides glyphosate and dicamba, no other herbicides were added in the tank during the POST application.

Your second question is not clear to me.

An update on whether/how our data are being used towards the EPA decision regarding the technology would be appreciated.

Best wishes,
Rodrigo

--
Rodrigo Werle, PhD
Assistant Professor & Weed Specialist
Department of Agronomy
University of Wisconsin-Madison
1575 Linden Drive, Madison, WI 53706
Office: 608-262-7130
Email: rwerle@wisc.edu
Twitter: @WiscWeeds
Departmental Webpage: https://agronomy.wisc.edu/rodrigo-werle/
WiscWeeds Blog: www.wiscweeds.info

From: Baris, Reuben [mailto:Baris.Reuben@epa.gov]
Sent: Thursday, October 11, 2018 1:08 PM
To: Rodrigo Werle <rwerle@wisc.edu>; Young, Bryan G <BryanYoung@purdue.edu>; Greg Kruger <greg.kruger@unl.edu>; sprague1@msu.edu; Reynolds, Dan <dreynolds@pss.msstate.edu>
Cc: Peck, Charles <Peck.Charles@epa.gov>; Jason Keith Norsworthy <jnorswor@uark.edu>
Subject: Large-scale dicamba studies: question RE: tank mixes

Drs. Werle, Young, Kruger, Sprague, Reynolds and Norsworthy:

I hope these are easy questions for you all. If you don't want to cc the whole group on this email, you can respond directly to me.

1) What were the tank mix(es) you used in your study for xtendimax off-target movement?
    - specifically, was acetochlor (e.g., warrant or other product) used?

2) Were there were any (notable) deviations that they made to the protocol when conducting the study

Thanks for your quick reply.
Reuben

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Site Description:

Location:	Arlington, WI	**Crop:**	Soybean
Field #:	713	**Variety 1 (RR2/Xtend):**	AG21X7
Soil type:	Plano silt loam	**Variety 2 (RR2):**	AG2035
pH:	6.7	**Planting Date:**	6/5
OM %:	3.5	**Population:**	140,000 seeds/acre
Previous crop:	Corn	**Depth:**	1.5 in
Tillage:	conventional	**Row spacing:**	30 in
		Plot Size:	8 acres

Maintenance Herbicide:

Pre-Plant Burndown: 5/14

Low Vol 4 (2,4-D)	1 pt/acre
Tomahawk 5 (gly)	24 oz/acre

Preemergence: 6/6

Medal II EC	24 oz/acre
Sonic	4 oz/acre

Herbicide Application Information:

Date:	7/11
Air Temp (°F):	81
2" Soil Temp (°F):	75
Soil moisture [surface]:	dry
RH %:	43
Cloud cover %	3
Wind speed (mph)/direction	3-6/SE
GPA:	15
PSI:	36
Nozzle:	TTI 11004
Nozzle spacing (in):	20
Boom Height (in):	32

Treatment	Rate
Roundup PowerMax	32 fl oz/A
Xtendimax	22 fl oz/A
Intact	.5% v/v

Crop Info

Height (in):	13
Growth Stage:	V6

Message

From: Peck, Charles [Peck.Charles@epa.gov]
Sent: 10/11/2018 2:07:10 PM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
CC: Corbin, Mark [Corbin.Mark@epa.gov]; Odenkirchen, Edward [Odenkirchen.Edward@epa.gov]; Baris, Reuben [Baris.Reuben@epa.gov]
Subject: RE: Follow-up Questions

Thanks Jason for the speedy response!

Chuck Peck
OPP/EFED/ERB VI
Potomac Yard South
Crystal City, VA
Room 10244
(703) 347-8064
peck.charles@epa.gov

From: Jason Keith Norsworthy [mailto:jnorswor@uark.edu]
Sent: Thursday, October 11, 2018 9:33 AM
To: Peck, Charles <Peck.Charles@epa.gov>
Cc: Corbin, Mark <Corbin.Mark@epa.gov>; Odenkirchen, Edward <Odenkirchen.Edward@epa.gov>; Baris, Reuben <Baris.Reuben@epa.gov>
Subject: RE: Follow-up Questions

Chuck,

Below are my responses to your questions.

Regards,
Jason

From: Peck, Charles <Peck.Charles@epa.gov>
Sent: Thursday, October 11, 2018 7:46 AM
To: Jason Keith Norsworthy <jnorswor@uark.edu>
Cc: Corbin, Mark <Corbin.Mark@epa.gov>; Odenkirchen, Edward <Odenkirchen.Edward@epa.gov>; Baris, Reuben <Baris.Reuben@epa.gov>
Subject: Follow-up Questions

Hi Dr. Norsworthy,

Sorry to keep pinging you with questions, but we had a meeting yesterday with our senior management and there were a couple of questions that were posed to us that we wanted to follow-up with you about.

1. Do you have any information regarding field observer scoring for visual damage (e.g. test plots for calibrating method or other training or testing of observers) and, if so, would you be willing to share it?

I practice with my crew at the beginning of every growing season using test plots to make sure they fully understanding the rating process. This is a typical procedure that is common for weed scientists worldwide.

2. Do you have any notes or photographs relating any observations of the treated portion of the field relative to plant condition and, if so, would you be willing to share them?

I do have photographs. I have attached one to this email. You will note that the treated area of the field showed no herbicide symptoms at 17 days after application. I do not have earlier photos but no symptoms were observed.

3. Do you have any notes or photographs related to observations of tarped/untarped or bucketed /unbucketed plants and, if so, would you be willing to share them? There was one photograph in your presentation, but we were wondering if you had any additional photographs, particularly regarding the bucketed/unbucketed plants.

I do not have photos from this year for the buckets but I do have photos from a similar trial conducted in 2017 taken 12 days after application. I have also attached it.

4. I may have asked you this before, but do you have any temperature or relative humidity data from the 2018 trial?

We were not successful in retrieving temperature and RH data from the loggers in the field, but I had another weather station 6 miles from which I do have temperature and RH at heights of 18, 60, and 120 inches on an hourly basis. I have attached these data.

As always, thank you very much for your help. Take care!

Chuck Peck
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Room 10244
(703) 347-8064
peck.charles@epa.gov

Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 10/26/2018 10:47:03 PM
To: Baris, Reuben [Baris.Reuben@epa.gov]
Subject: Air sample and filter paper data
Attachments: Norsworthy AR Air Sample and Filter Paper Data Proctor AR (EPA).xlsx

Reuben,

Attached please find the air sample puff and filter paper data that were collected at Proctor, AR (XtendiMax drift/volatility trial). Dr. Ashli Brown at MS State University analyzed the samples and sent me these data. Let me know if you have questions.

Regards,
Jason

Jason Norsworthy, PhD
Professor and Elms Farming Chair of Weed Science
1366 West Altheimer Dr.
Fayetteville, AR 72704
Tel: 479-575-8740
Mob: 479-313-1265

Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 9/13/2018 8:07:10 PM
To: Baris, Reuben [Baris.Reuben@epa.gov]
Subject: RE: formal request

All the names I sent you were for XtendiMax.

From: Baris, Reuben <Baris.Reuben@epa.gov>
Sent: Thursday, September 13, 2018 1:54 PM
To: Jason Keith Norsworthy <jnorswor@uark.edu>
Subject: RE: formal request

Interesting.

I thought all of these studies were on Xtendimax. I plan to call Dan.

Thanks again.
reuben

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From: Jason Keith Norsworthy [mailto:jnorswor@uark.edu]
Sent: Thursday, September 13, 2018 2:50 PM
To: Baris, Reuben <Baris.Reuben@epa.gov>
Subject: RE: formal request

According to Dan Reynolds, she should have the BASF samples completed soon and then she will begin the Monsanto samples. I don't know how long that will take. Between BASF and Monsanto, there are hundreds of samples that are being analyzed (probably 1,000 or more total). You may try reaching out to Dan Reynolds (dreynolds@pss.msstate.edu). He is the one overseeing air samples coming into MS State. All universities are sending samples to Brown's lab this summer. I will share the results just as soon as they become available.

Jason Norsworthy, PhD
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Fayetteville, AR 72704
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Mob: 479-313-1265

From: Baris, Reuben <Baris.Reuben@epa.gov>
Sent: Thursday, September 13, 2018 1:43 PM
To: Jason Keith Norsworthy <jnorswor@uark.edu>
Subject: RE: formal request

Thanks Jason. I think this will be very helpful.

Related to Dr. Brown, do you know when you're expecting the data back or when you'd be able to share the air sampling analysis with EPA?

I really do appreciate everything you're doing.

REUBEN BARIS | PRODUCT MANAGER, TEAM 25 | HERBICIDE BRANCH
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From: Jason Keith Norsworthy [mailto:jnorswor@uark.edu]
Sent: Thursday, September 13, 2018 2:30 PM
To: Baris, Reuben <Baris.Reuben@epa.gov>
Subject: RE: formal request

Reuben,

Attached please find the assessments collected from the large-plot trial that I conducted in conjunction with Monsanto at Proctor, AR. Dr. Ashley Brown from MS State University is analyzing the air sample data collected from this trial. I have attached some slides that should help explain what was observed at this location. Let me know if you need anything else or have questions about the trial.

Regards,
Jason

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From: Baris, Reuben <Baris.Reuben@epa.gov>
Sent: Thursday, September 13, 2018 11:27 AM
To: Jason Keith Norsworthy <jnorswor@uark.edu>
Subject: formal request

Hey Jason,
This is the formal request, if you're willing, to share the data from your Proctor, AR study on the 240 acre, 80 acre block study.

Happy to discuss more by phone if necessary to talk about mechanisms for sharing with EPA.
Reuben

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Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 9/13/2018 8:06:23 PM
To: Baris, Reuben [Baris.Reuben@epa.gov]
Subject: RE: Proctor, Arkansas

33, 55, 90 and 150 cm

From: Baris, Reuben <Baris.Reuben@epa.gov>
Sent: Thursday, September 13, 2018 2:42 PM
To: Jason Keith Norsworthy <jnorswor@uark.edu>
Subject: Fwd: Proctor, Arkansas

Early reads from our modelers...

Are you able to answer Chuck's question?

Sent from my iPhone

Begin forwarded message:

> **From:** "Peck, Charles" <Peck.Charles@epa.gov>
> **Date:** September 13, 2018 at 3:39:12 PM EDT
> **To:** "Baris, Reuben" <Baris.Reuben@epa.gov>, "Corbin, Mark" <Corbin.Mark@epa.gov>
> **Cc:** "Odenkirchen, Edward" <Odenkirchen.Edward@epa.gov>, "Echeverria, Marietta" <Echeverria.Marietta@epa.gov>
> **Subject: RE: Proctor, Arkansas**
>
> Hi Reuben,
>
> Can you confirm with Dr. Norsworthy that in the "Proctor_Dicamba_Weather_CR300Series_TableOUT.xlsx" file, the WindDir0 and WindSpd0 correspond to the samplers at height 0.15 m, WindDir1 and WindSpd1 correspond to samplers at height 0.33 m, etc? and that these are met conditions at the center mast?
>
> Thanks! Interesting stuff!
>
> Chuck Peck
> OPP/EFED/ERB VI
> Potomac Yard South
> Crystal City, VA
> Room 10244
> (703) 347-8064
> peck.charles@epa.gov
>
> **From:** Baris, Reuben
> **Sent:** Thursday, September 13, 2018 3:25 PM
> **To:** Corbin, Mark <Corbin.Mark@epa.gov>
> **Cc:** Odenkirchen, Edward <Odenkirchen.Edward@epa.gov>; Peck, Charles <Peck.Charles@epa.gov>;

Echeverria, Marietta <Echeverria.Marietta@epa.gov>
Subject: Re: Proctor, Arkansas

Don't know timing. Only sent out requests this week.

Sent from my iPhone

On Sep 13, 2018, at 3:16 PM, Corbin, Mark <Corbin.Mark@epa.gov> wrote:

> Thanks
>
> I can give it a quick look tomorrow. Chuck is off
>
> Looking at it on my phone it
> Definitely looks interesting. Similar methods to Jones with distinction between primary (I assume drift) and secondary (I assume volatility) using tarps.
>
> Do you have a sense when the other data might be coming?
>
> Mark
>
> Sent from my iPhone
>
> On Sep 13, 2018, at 2:49 PM, Baris, Reuben <Baris.Reuben@epa.gov> wrote:
>
>> Mark,
>> This is the first of a few emails on additional data.
>>
>> I know you have a lot of things going on, but can you all screen this and make a call if this or anything like this would be helpful/informative.
>>
>> Note this study has accompanying air sampling (see protocol previously shared) but has not yet been completed. I expect to receive similar submissions from Wisconsin, Indiana, Michigan, and Nebraska.
>> Thank you.
>> Reuben
>>
>> REUBEN BARIS | PRODUCT MANAGER, TEAM 25 | HERBICIDE BRANCH
>> U.S. ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF PESTICIDE PROGRAMS
>> | (703) 305-7356
>>
>> **From:** Jason Keith Norsworthy [mailto:jnorswor@uark.edu]
>> **Sent:** Thursday, September 13, 2018 2:30 PM
>> **To:** Baris, Reuben <Baris.Reuben@epa.gov>
>> **Subject:** RE: formal request
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explain what was observed at this location. Let me know if you need anything else or have questions about the trial.

Regards,
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To: Jason Keith Norsworthy <jnorswor@uark.edu>
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<EPA Proctor slides (PDF).pdf>

<Monsanto large drift Proctor data_.xlsx>

<Proctor_Dicamba_Weather_CR300Series_TableOUT.xlsx>

Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 9/13/2018 6:49:38 PM
To: Baris, Reuben [Baris.Reuben@epa.gov]
Subject: RE: formal request

According to Dan Reynolds, she should have the BASF samples completed soon and then she will begin the Monsanto samples. I don't know how long that will take. Between BASF and Monsanto, there are hundreds of samples that are being analyzed (probably 1,000 or more total). You may try reaching out to Dan Reynolds (dreynolds@pss.msstate.edu). He is the one overseeing air samples coming into MS State. All universities are sending samples to Brown's lab this summer. I will share the results just as soon as they become available.

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Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 10/11/2018 1:32:45 PM
To: Peck, Charles [Peck.Charles@epa.gov]
CC: Corbin, Mark [Corbin.Mark@epa.gov]; Odenkirchen, Edward [Odenkirchen.Edward@epa.gov]; Baris, Reuben [Baris.Reuben@epa.gov]
Subject: RE: Follow-up Questions
Attachments: Temperature and humidity data.xps; EPA (requested photos).ppt

Chuck,

Below are my responses to your questions.

Regards,
Jason

From: Peck, Charles <Peck.Charles@epa.gov>
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OPP/EFED/ERB VI
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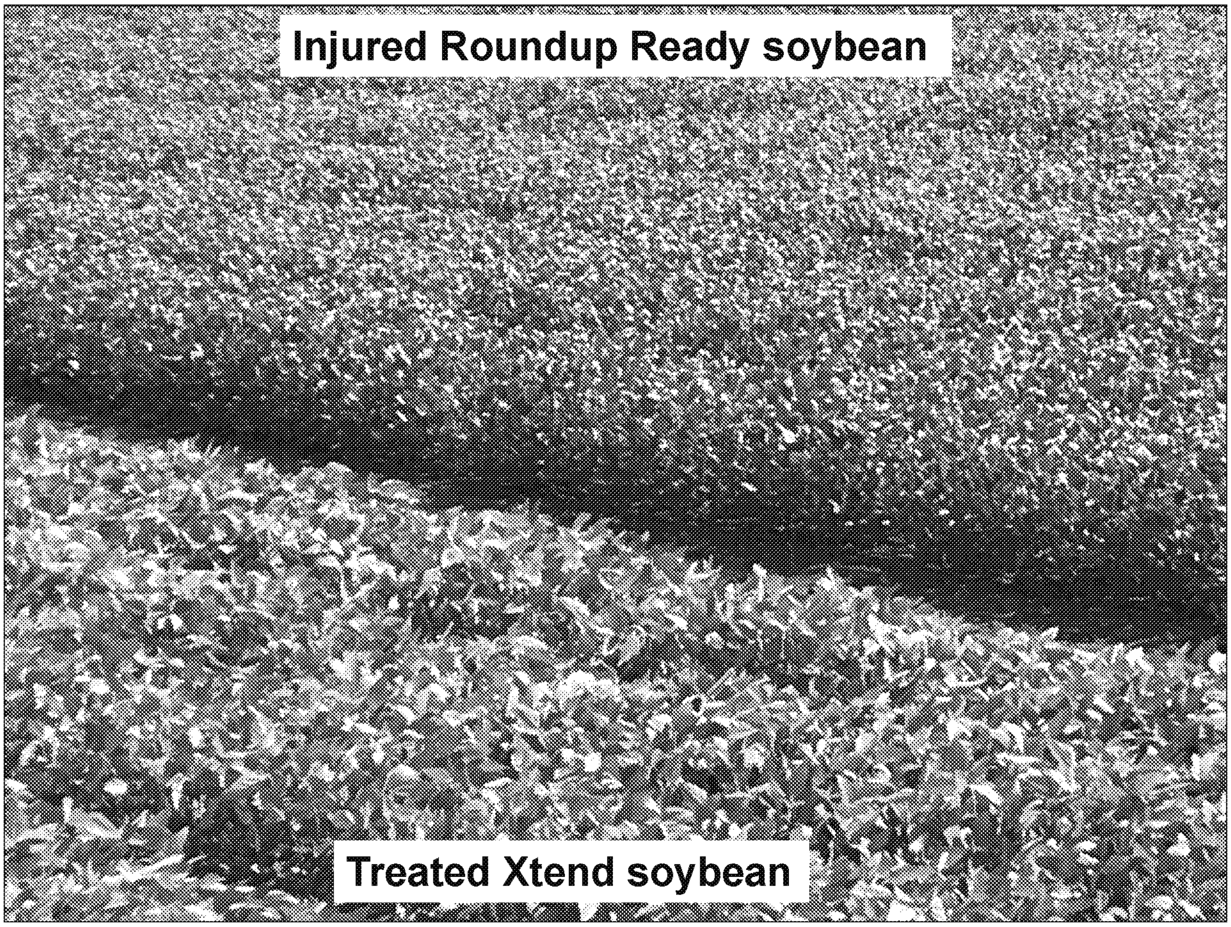
This photograph was taken from a trial at Keiser, AR in 2017 under warmer conditions than experienced at Proctor. Note how plants adjacent to those covered by the bucket (marked by pink flag) were removed to prevent contamination. This photo was taken 12 days after application.


Injured Roundup Ready soybean
Treated Xtend soybean

TIMESTAMP	Air Temp (1	RH (18 inch	Air temp (6	RH (60 inch	Air Temp (1	RH (120 inch)
TS	Deg C	%	Deg C	%	Deg C	%
	Avg	Smp	Avg	Smp	Avg	Smp
7/16/2018 0:00	23.9	96.3	23.87	96.4	23.96	95.6
7/16/2018 1:00	23.95	97.4	23.93	97.5	24.01	96.4
7/16/2018 2:00	24	95.9	24.01	95.8	24.11	94.9
7/16/2018 3:00	24.18	97.4	24.19	97.1	24.31	96
7/16/2018 4:00	24.2	98.1	24.19	98.2	24.31	97.2
7/16/2018 5:00	24.02	98.1	24.01	98.4	24.12	97.5
7/16/2018 6:00	23.9	99	23.92	99	24.03	97.9
7/16/2018 7:00	23.96	96.2	23.98	96.4	24.07	95.4
7/16/2018 8:00	25	94.9	24.81	94.7	24.83	93.7
7/16/2018 9:00	26.31	90.2	25.95	90.9	25.92	89.8
7/16/2018 10:00	27.48	88.7	27.07	87.8	27.03	85
7/16/2018 11:00	28.64	78.62	28.23	77.06	28.18	75.63
7/16/2018 12:00	30.02	72.37	29.55	72.44	29.44	72.03
7/16/2018 13:00	30.97	74.46	30.39	73	30.32	71.81
7/16/2018 14:00	32	68.02	31.35	66.73	31.33	67.68
7/16/2018 15:00	33.1	65.68	32.29	66.46	32.23	63.6
7/16/2018 16:00	33.13	69.72	32.48	67.85	32.45	65.17
7/16/2018 17:00	32.7	62.45	32.37	61.53	32.37	59.59
7/16/2018 18:00	32.46	71.15	32.11	69.75	32.11	69.04
7/16/2018 19:00	31.52	81.7	31.24	82	31.31	80.2
7/16/2018 20:00	29.78	89.8	29.64	90.2	29.74	89.3
7/16/2018 21:00	28.71	91.6	28.6	92.3	28.69	91.3
7/16/2018 22:00	28.08	95.1	28.02	95.2	28.12	93.9
7/16/2018 23:00	27.41	95.4	27.43	95.4	27.55	94.2
7/17/2018 0:00	26.77	95.4	26.77	95.5	26.89	94.3
7/17/2018 1:00	26.29	96.3	26.25	96.6	26.37	95.5
7/17/2018 2:00	25.55	96.1	25.54	96.1	25.65	95
7/17/2018 3:00	24.94	98.3	24.92	98.5	25.05	97.6
7/17/2018 4:00	24.6	98.7	24.59	98.9	24.72	97.8
7/17/2018 5:00	24.27	98.8	24.31	99	24.44	98
7/17/2018 6:00	24.1	99.1	24.12	99.6	24.22	98.7
7/17/2018 7:00	24.09	99.2	24.07	99.3	24.17	98.5
7/17/2018 8:00	25.28	93.6	25.05	94.3	25.11	93.5
7/17/2018 9:00	26.88	82.4	26.37	84.4	26.39	83.6
7/17/2018 10:00	28.21	79.39	27.44	81.5	27.37	80.6
7/17/2018 11:00	29.68	72	28.9	75.36	28.8	74.89
7/17/2018 12:00	31.04	65.64	30.11	68.84	29.97	68.63
7/17/2018 13:00	32	67.2	30.93	68.53	30.8	64.93
7/17/2018 14:00	32.56	62.11	31.64	63.23	31.56	63.33
7/17/2018 15:00	33.31	66.29	32.44	68.22	32.31	65.3
7/17/2018 16:00	32.88	60.54	32.25	61.7	32.15	61.09

Message

From: Peck, Charles [Peck.Charles@epa.gov]
Sent: 10/11/2018 12:45:57 PM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
CC: Corbin, Mark [Corbin.Mark@epa.gov]; Odenkirchen, Edward [Odenkirchen.Edward@epa.gov]; Baris, Reuben [Baris.Reuben@epa.gov]
Subject: Follow-up Questions

Hi Dr. Norsworthy,

Sorry to keep pinging you with questions, but we had a meeting yesterday with our senior management and there were a couple of questions that were posed to us that we wanted to follow-up with you about.

1. Do you have any information regarding field observer scoring for visual damage (e.g. test plots for calibrating method or other training or testing of observers) and, if so, would you be willing to share it?
2. Do you have any notes or photographs relating any observations of the treated portion of the field relative to plant condition and, if so, would you be willing to share them?
3. Do you have any notes or photographs related to observations of tarped/untarped or bucketed /unbucketed plants and, if so, would you be willing to share them? There was one photograph in your presentation, but we were wondering if you had any additional photographs, particularly regarding the bucketed/unbucketed plants.
4. I may have asked you this before, but do you have any temperature or relative humidity data from the 2018 trial?

As always, thank you very much for your help. Take care!

Chuck Peck
OPP/EFED/ERB VI
Potomac Yard South
Crystal City, VA
Room 10244
(703) 347-8064
peck.charles@epa.gov

Message

From: Peck, Charles [Peck.Charles@epa.gov]
Sent: 10/23/2018 11:58:15 AM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
CC: Corbin, Mark [Corbin.Mark@epa.gov]; Baris, Reuben [Baris.Reuben@epa.gov]; Odenkirchen, Edward [Odenkirchen.Edward@epa.gov]
Subject: RE: Questions on Trials Presented in AR State Board Presentation

Thank you!

From: Jason Keith Norsworthy [mailto:jnorswor@uark.edu]
Sent: Tuesday, October 23, 2018 7:54 AM
To: Peck, Charles <Peck.Charles@epa.gov>
Cc: Corbin, Mark <Corbin.Mark@epa.gov>; Baris, Reuben <Baris.Reuben@epa.gov>; Odenkirchen, Edward <Odenkirchen.Edward@epa.gov>
Subject: RE: Questions on Trials Presented in AR State Board Presentation

Correct. This has been standard practice for all low tunnel trial research conducted by myself and colleagues, including Monsanto and Dow AgroSciences over the past six years. The goal is to spray only enough surface area at a high enough rate to try and differentiate formulations. An alternative would be to spray 8 flats of soil at a 1X rate rather than 2 trays at a 4X rate.

Jason Norsworthy, PhD
Professor and Elms Farming Chair of Weed Science
1366 West Altheimer Dr.
Fayetteville, AR 72704
Tel: 479-575-8740
Mob: 479-313-1265

From: Peck, Charles <Peck.Charles@epa.gov>
Sent: Tuesday, October 23, 2018 6:50 AM
To: Jason Keith Norsworthy <jnorswor@uark.edu>
Cc: Corbin, Mark <Corbin.Mark@epa.gov>; Baris, Reuben <Baris.Reuben@epa.gov>; Odenkirchen, Edward <Odenkirchen.Edward@epa.gov>
Subject: RE: Questions on Trials Presented in AR State Board Presentation

Hi Jason,

So just to confirm, the tunnel studies were done at a rate of roughly 2 lbs ae/A of dicamba and 4 lbs ae/A of glyphosate?

I'll look at the large trial that was done with Xtendimax and Xtendimax plus glyphosate for the comparison – thanks!

Chuck Peck
OPP/EFED/ERB VI
Potomac Yard South
Crystal City, VA
Room 10244
(703) 347-8064

peck.charles@epa.gov

From: Jason Keith Norsworthy [mailto:jnorswor@uark.edu]
Sent: Tuesday, October 23, 2018 7:42 AM
To: Peck, Charles <Peck.Charles@epa.gov>
Subject: RE: Questions on Trials Presented in AR State Board Presentation

See below responses.

From: Peck, Charles <Peck.Charles@epa.gov>
Sent: Tuesday, October 23, 2018 6:34 AM
To: Jason Keith Norsworthy <jnorswor@uark.edu>
Cc: Corbin, Mark <Corbin.Mark@epa.gov>; Odenkirchen, Edward <Odenkirchen.Edward@epa.gov>; Baris, Reuben <Baris.Reuben@epa.gov>
Subject: Questions on Trials Presented in AR State Board Presentation

Hi Dr. Norsworthy,

I had some questions regarding the information provided in your 2018 presentation to the Arkansas State Board on Sep 20, 2018.

Slides 56-67 discuss the tunnel volatility studies that you conducted

1. On slide 56, the date is September 18, 2018. Is this the date when the trials were conducted, or just the date of the photo? If it reflects when the trials were conducted, I don't understand how the analysis could have been performed and then presented on Sep 20th?
   September 18 was the date the photo was taken that shows how the tunnels appear in the field. The data presented were from earlier studies in the summer.

2. What were the application rates for the trials? Was it the standard 0.5 lb ae/A for dicamba products and 1 lb ae/A for glyphosate products?
   A 4X rate of herbicide is used in the low tunnel volatility studies because we only treat two flats of soil that are 12 by 18 inches. These trays are removed from the tunnels 48 hours after introduction into the tunnel.
3. On slide 60, there is a comparison of Engenia with and without Roundup, but none with Xtendimax without Roundup. Did you conduct any trials with just Xtendimax alone?
   I have a trial with and without Xtendimax that was initiated 4 weeks ago. I rated it yesterday and saw a similar effect. I also have the large plot drift trial that was conducted at Keiser comparing Xtendimax + Roundup to an application without Xtendimax. In addition to the data shown in the slides, there was less injury to covered plants when glyphosate was removed from Xtendimax.
4. On slide 69, there is a comparison of the pH values for different tank mix solutions. Were these part of the tunnel volatility study, or something different? These were part of a tunnel volatility study that was initiated late in the year. I was only showing here that glyphosate further lowers the pH of Xtendimax, which may contribute to the increased volatility.

As always, thank you very much for your help!

Chuck Peck
OPP/EFED/ERB VI
Potomac Yard South
Crystal City, VA
Room 10244
(703) 347-8064
peck.charles@epa.gov

Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 10/23/2018 11:53:39 AM
To: Peck, Charles [Peck.Charles@epa.gov]
CC: Corbin, Mark [Corbin.Mark@epa.gov]; Baris, Reuben [Baris.Reuben@epa.gov]; Odenkirchen, Edward [Odenkirchen.Edward@epa.gov]
Subject: RE: Questions on Trials Presented in AR State Board Presentation

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To: Jason Keith Norsworthy <jnorswor@uark.edu>
Cc: Corbin, Mark <Corbin.Mark@epa.gov>; Baris, Reuben <Baris.Reuben@epa.gov>; Odenkirchen, Edward <Odenkirchen.Edward@epa.gov>
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Sent: Tuesday, October 23, 2018 7:42 AM
To: Peck, Charles <Peck.Charles@epa.gov>
Subject: RE: Questions on Trials Presented in AR State Board Presentation

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Sent: Tuesday, October 23, 2018 6:34 AM
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Cc: Corbin, Mark <Corbin.Mark@epa.gov>; Odenkirchen, Edward <Odenkirchen.Edward@epa.gov>; Baris, Reuben <Baris.Reuben@epa.gov>
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As always, thank you very much for your help!

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Sent: 10/23/2018 11:50:15 AM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
CC: Corbin, Mark [Corbin.Mark@epa.gov]; Baris, Reuben [Baris.Reuben@epa.gov]; Odenkirchen, Edward [Odenkirchen.Edward@epa.gov]
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Sent: Tuesday, October 23, 2018 7:42 AM
To: Peck, Charles <Peck.Charles@epa.gov>
Subject: RE: Questions on Trials Presented in AR State Board Presentation

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To: Jason Keith Norsworthy <jnorswor@uark.edu>
Cc: Corbin, Mark <Corbin.Mark@epa.gov>; Odenkirchen, Edward <Odenkirchen.Edward@epa.gov>; Baris, Reuben <Baris.Reuben@epa.gov>
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peck.charles@epa.gov

Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 9/12/2018 2:25:18 PM
To: Baris, Reuben [Baris.Reuben@epa.gov]
Subject: protocol and guidelines attached
Attachments: FieldSteps.pptx; Academic Large Scale OTM Assesment_2018_04-09.docx

Jason Norsworthy, PhD
Professor and Elms Farming Chair of Weed Science
1366 West Altheimer Dr.
Fayetteville, AR 72704
Tel: 479-575-8740
Mob: 479-313-1265

Message

From: Peck, Charles [Peck.Charles@epa.gov]
Sent: 10/23/2018 11:33:49 AM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
CC: Corbin, Mark [Corbin.Mark@epa.gov]; Odenkirchen, Edward [Odenkirchen.Edward@epa.gov]; Baris, Reuben [Baris.Reuben@epa.gov]
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As always, thank you very much for your help!

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Room 10244
(703) 347-8064
peck.charles@epa.gov

Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 9/11/2018 8:57:35 PM
To: Baris, Reuben [Baris.Reuben@epa.gov]
Subject: Re: Where is your 240 block study?

Proctor, AR

Sent from my iPhone

On Sep 11, 2018, at 2:52 PM, Baris, Reuben <Baris.Reuben@epa.gov> wrote:

> The one you took us to.
>
> AR or MO?
>
> Sent from my iPhone

Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 9/11/2018 8:57:08 PM
To: Baris, Reuben [Baris.Reuben@epa.gov]
Subject: Re: Where is your 240 block study?

AR

Sent from my iPhone

On Sep 11, 2018, at 2:52 PM, Baris, Reuben <Baris.Reuben@epa.gov> wrote:

> The one you took us to.
>
> AR or MO?
>
> Sent from my iPhone

Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 9/9/2018 3:24:02 AM
To: Baris, Reuben [Baris.Reuben@epa.gov]
Subject: Re: two apps in cotton

There really would need to be a cutoff with that application.

Sent from my iPhone

On Sep 8, 2018, at 10:13 PM, Baris, Reuben <Baris.Reuben@epa.gov> wrote:

> Hi Jason,
> Could cotton growers live with one application in cotton?
> Reuben
>
> REUBEN BARIS | PRODUCT MANAGER, TEAM 25 | HERBICIDE BRANCH
> U.S. ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF PESTICIDE PROGRAMS | (703) 305-7356

Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 9/9/2018 3:21:22 AM
To: Baris, Reuben [Baris.Reuben@epa.gov]
Subject: Re: two apps in cotton

Yes. They have glufosinate that can be sprayed on Xtend cotton for pigweed control.

Sent from my iPhone

On Sep 8, 2018, at 10:13 PM, Baris, Reuben <Baris.Reuben@epa.gov> wrote:

> Hi Jason,
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Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 9/18/2018 4:47:58 PM
To: Baris, Reuben [Baris.Reuben@epa.gov]
Subject: Proctor data

Hi Rueben,

Can you please confirm Bayer's position on my XtendiMax data from Arkansas? I am interested to understand on what grounds they are dismissing the data when our first opportunity to share the results will not be until Wednesday at which time I will meet with Drs. John Chambers (formerly with Monsanto), Ty Witten (formerly with Monsanto), Bob Montgomery (formerly with Monsanto), and Ms. Arlene Cotie with Bayer CropScience.

I look forward to hearing from you.

Regards,
Jason

Jason Norsworthy, PhD
Professor and Elms Farming Chair of Weed Science
1366 West Altheimer Dr.
Fayetteville, AR 72704
Tel: 479-575-8740
Mob: 479-313-1265

Message

From: Sprague, Christy [sprague1@msu.edu]
Sent: 10/12/2018 11:26:08 PM
To: Greg Kruger [greg.kruger@unl.edu]; Young, Bryan G [BryanYoung@purdue.edu]
CC: Baris, Reuben [Baris.Reuben@epa.gov]; Peck, Charles [Peck.Charles@epa.gov]; Jason Keith Norsworthy [jnorswor@uark.edu]; Rodrigo Werle [rwerle@wisc.edu]; Reynolds, Dan [dreynolds@pss.msstate.edu]
Subject: RE: Large-scale dicamba studies: question RE: tank mixes

MSU also did the same as Bryan and Greg.

Sincerely,
Christy

From: Greg Kruger <greg.kruger@unl.edu>
Sent: Friday, October 12, 2018 6:17 PM
To: Young, Bryan G <BryanYoung@purdue.edu>
Cc: Baris, Reuben <Baris.Reuben@epa.gov>; Peck, Charles <Peck.Charles@epa.gov>; Jason Keith Norsworthy <jnorswor@uark.edu>; Rodrigo Werle <rwerle@wisc.edu>; Sprague, Christy <sprague1@msu.edu>; Reynolds, Dan <dreynolds@pss.msstate.edu>
Subject: Re: Large-scale dicamba studies: question RE: tank mixes

My answers are the same as Bryan's.

Greg

Sent from my iPhone

On Oct 11, 2018, at 2:15 PM, Young, Bryan G <BryanYoung@purdue.edu> wrote:

> Reuben,
>
> Answer #1 - One tankmix at 15 GPA with the following products:
> Xtendimax @ 22 oz/A
> Roundup PowerMax @ 32 oz/A
> Intact DRA @ 0.5% v/v
>
> Answer #2 – No deviations from the protocol shared by Monsanto were implemented.
>
> Best,
> Bryan
>
> Bryan Young
> Professor of Weed Science
> Department of Botany and Plant Pathology
> **Purdue** University
> 1351 Lilly Hall of Life Sciences
> 915 West State Street
> W. Lafayette, IN 47907
> Email: BryanYoung@Purdue.edu
> Voice: 765.496.1646

From: Baris, Reuben <Baris.Reuben@epa.gov>
Sent: Thursday, October 11, 2018 2:08 PM
To: Rodrigo Werle <rwerle@wisc.edu>; Young, Bryan G <BryanYoung@purdue.edu>; Greg Kruger <greg.kruger@unl.edu>; sprague1@msu.edu; Reynolds, Dan <dreynolds@pss.msstate.edu>
Cc: Peck, Charles <Peck.Charles@epa.gov>; Jason Keith Norsworthy <jnorswor@uark.edu>
Subject: Large-scale dicamba studies: question RE: tank mixes

Drs. Werle, Young, Kruger, Sprague, Reynolds and Norsworthy:

I hope these are easy questions for you all. If you don't want to cc the whole group on this email, you can respond directly to me.

1) What were the tank mix(es) you used in your study for xtendimax off-target movement?
- specifically, was acetochlor (e.g., warrant or other product) used?

2) Were there were any (notable) deviations that they made to the protocol when conducting the study

Thanks for your quick reply.
Reuben

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Message

From: Greg Kruger [greg.kruger@unl.edu]
Sent: 10/12/2018 10:16:55 AM
To: Young, Bryan G [BryanYoung@purdue.edu]
CC: Baris, Reuben [Baris.Reuben@epa.gov]; Peck, Charles [Peck.Charles@epa.gov]; Jason Keith Norsworthy [jnorswor@uark.edu]; Rodrigo Werle [rwerle@wisc.edu]; sprague1@msu.edu; Reynolds, Dan [dreynolds@pss.msstate.edu]
Subject: Re: Large-scale dicamba studies: question RE: tank mixes

My answers are the same as Bryan's.

Greg

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Best,
Bryan

Bryan Young
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Email: BryanYoung@Purdue.edu
Voice: 765.496.1646

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Sent: Thursday, October 11, 2018 2:08 PM
To: Rodrigo Werle <rwerle@wisc.edu>; Young, Bryan G <BryanYoung@purdue.edu>; Greg Kruger <greg.kruger@unl.edu>; sprague1@msu.edu; Reynolds, Dan <dreynolds@pss.msstate.edu>
Cc: Peck, Charles <Peck.Charles@epa.gov>; Jason Keith Norsworthy <jnorswor@uark.edu>
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Message

From: Greg Kruger [greg.kruger@unl.edu]
Sent: 1/28/2018 2:20:40 PM
To: Baris, Reuben [Baris.Reuben@epa.gov]; Barrett, Michael [mbarrett@uky.edu]; Jill Schroeder [jill.schroeder@ars.usda.gov]
CC: tmueller@tennessee.edu; Bradleyke@missouri.edu; Reynolds, Dan [dreynolds@pss.msstate.edu]; ALFRED Culpepper [stanley@uga.edu]; Bryan Young (BryanYoung@purdue.edu) [BryanYoung@purdue.edu]; Jason Keith Norsworthy [jnorswor@uark.edu]; Steckel, Larry [lsteckel@utk.edu]; Aaron Hager [hager@illinois.edu]; Zollinger, Richard [r.zollinger@ndsu.edu]; mdowen@iastate.edu; Senseman, Scott [ssensema@utk.edu]; 'David Shaw' [dshaw@research.msstate.edu]; Scott Bretthauer [SBretthauer@agaviation.org]
Subject: RE: Meeting at EPA

All,

This is a last minute reminder that tomorrow we will be meeting with EPA.

I know some of you have told me that you cannot make the meeting, but I am keeping you in the loop just in case something has changed. I would like to assemble everybody that has interest in going and can make the meeting in the lobby of the Marriott at 12:45. Once assembled, we will walk over to the EPA headquarters. Google maps shows says it is a 16 minute (0.9 mile walk). I will have a taxi arranged to take anybody who doesn't want to walk come pick you up. If you are not interested in walking and haven't already told me so, please let me know as soon as possible so that I know if I need more than one car. The meeting will start at 1:30, but it will take a little time to get everybody through security once we get to the building. Reuben will be there to help us get through. For those that haven't been there, if you are bringing a computer, please be prepared to pull it out and registered it once we get there. Getting into the building will be very similar to your experiences with TSA.

I want to thank you all for taking time to share your research and field experiences. I know this will be very valuable for EPA.

Best wishes,

Greg

-----Original Message-----
From: Greg Kruger
Sent: Wednesday, January 3, 2018 4:24 PM
To: Baris, Reuben <Baris.Reuben@epa.gov>; Barrett, Michael <mbarrett@uky.edu>; Jill Schroeder <jill.schroeder@ars.usda.gov>
Cc: tmueller@tennessee.edu; Bradleyke@missouri.edu; Reynolds, Dan <dreynolds@pss.msstate.edu>; ALFRED Culpepper <stanley@uga.edu>; Bryan Young (BryanYoung@purdue.edu) <BryanYoung@purdue.edu>; Jason Keith Norsworthy <jnorswor@uark.edu>; Steckel, Larry <lsteckel@utk.edu>; Aaron Hager <hager@illinois.edu>; Zollinger, Richard <r.zollinger@ndsu.edu>; mdowen@iastate.edu; Senseman, Scott <ssensema@utk.edu>
Subject: RE: Meeting at EPA

All,

I hope 2017 turned out well for you and 2018 is off and running! Since WSSA is just around the corner and since it is Crystal City this year, we want to take full advantage of the proximity to EPA. I have been working with Reuben Baris at EPA to set up a meeting to discuss off-target movement of dicamba. We know that there is never going to be a convenient time for everybody, but we have settled on trying to do the meeting on Monday January 29th at 1:30 pm. We will keep the meeting short (1 hour) at EPA headquarters. This means that we will have about a 15 minute walk from the hotel or I can see if we can get a shuttle arranged if enough people are interested in going that route. I would like to get the group walking towards EPA headquarters at 12:45 because it will take a little time to get through security once we get there. The main purpose of the meeting will be to give you guys a chance to share with EPA what questions you are asking (of the growers and of industry), what you are working on, and what you are finding related to off-target movement of dicamba. It is our hope that it will then lead into a discussion on what are the implications for 2018. If you are both willing and able to make the meeting, please let me know by next Wednesday so that I can have a head count.

Thanks,

Greg

Message

From: Peck, Charles [Peck.Charles@epa.gov]
Sent: 10/19/2018 4:18:03 PM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
CC: Baris, Reuben [Baris.Reuben@epa.gov]; Echeverria, Marietta [Echeverria.Marietta@epa.gov]; Corbin, Mark [Corbin.Mark@epa.gov]; Odenkirchen, Edward [Odenkirchen.Edward@epa.gov]
Subject: RE: Question Regarding 2017 Field Small Field Study

Great! Thank you very much and have a great weekend!

Chuck Peck
OPP/EFED/ERB VI
Potomac Yard South
Crystal City, VA
Room 10244
(703) 347-8064
peck.charles@epa.gov

From: Jason Keith Norsworthy [mailto:jnorswor@uark.edu]
Sent: Friday, October 19, 2018 12:14 PM
To: Peck, Charles <Peck.Charles@epa.gov>
Subject: RE: Question Regarding 2017 Field Small Field Study

I believe there were 10 plants from each location.

From: Peck, Charles <Peck.Charles@epa.gov>
Sent: Friday, October 19, 2018 8:58 AM
To: Jason Keith Norsworthy <jnorswor@uark.edu>
Cc: Corbin, Mark <Corbin.Mark@epa.gov>; Odenkirchen, Edward <Odenkirchen.Edward@epa.gov>; Baris, Reuben <Baris.Reuben@epa.gov>
Subject: Question Regarding 2017 Field Small Field Study

Hi Dr. Norsworthy,

I have a question regarding the spreadsheet you sent pertaining to the 2017 small field studies that were done in NE, AR. TN, MO, and IN. In the spreadsheet you provided plant height and visual injury measurements for the AR (08-14 volatility – North worksheet). Do you know the number of plants sampled at each distance to develop the visual injury and plant height estimates at the different distances along the transects?

As always, thank you very much for your help with this!

Chuck Peck
OPP/EFED/ERB VI
Potomac Yard South
Crystal City, VA
Room 10244
(703) 347-8064
peck.charles@epa.gov

Message

From: Peck, Charles [Peck.Charles@epa.gov]
Sent: 10/19/2018 1:57:37 PM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
CC: Corbin, Mark [Corbin.Mark@epa.gov]; Odenkirchen, Edward [Odenkirchen.Edward@epa.gov]; Baris, Reuben [Baris.Reuben@epa.gov]
Subject: Question Regarding 2017 Field Small Field Study

Hi Dr. Norsworthy,

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As always, thank you very much for your help with this!

Chuck Peck
OPP/EFED/ERB VI
Potomac Yard South
Crystal City, VA
Room 10244
(703) 347-8064
peck.charles@epa.gov

Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 10/4/2018 4:31:33 PM
To: Baris, Reuben [Baris.Reuben@epa.gov]
Subject: State Plant Board slides
Attachments: Arkansas State Plant Board Auxins (Sept 20, 2018) [Compatibility Mode].pdf

Actually I'm able to send the presentation because it is less than 20 MB.

Jason Norsworthy, PhD
Professor and Elms Farming Chair of Weed Science
1366 West Altheimer Dr.
Fayetteville, AR 72704
Tel: 479-575-8740
Mob: 479-313-1265

Learnings from 2018 on Off-target Movement of Auxin Herbicides

Jason K. Norsworthy
Professor and Elms Farming Chair of Weed Science

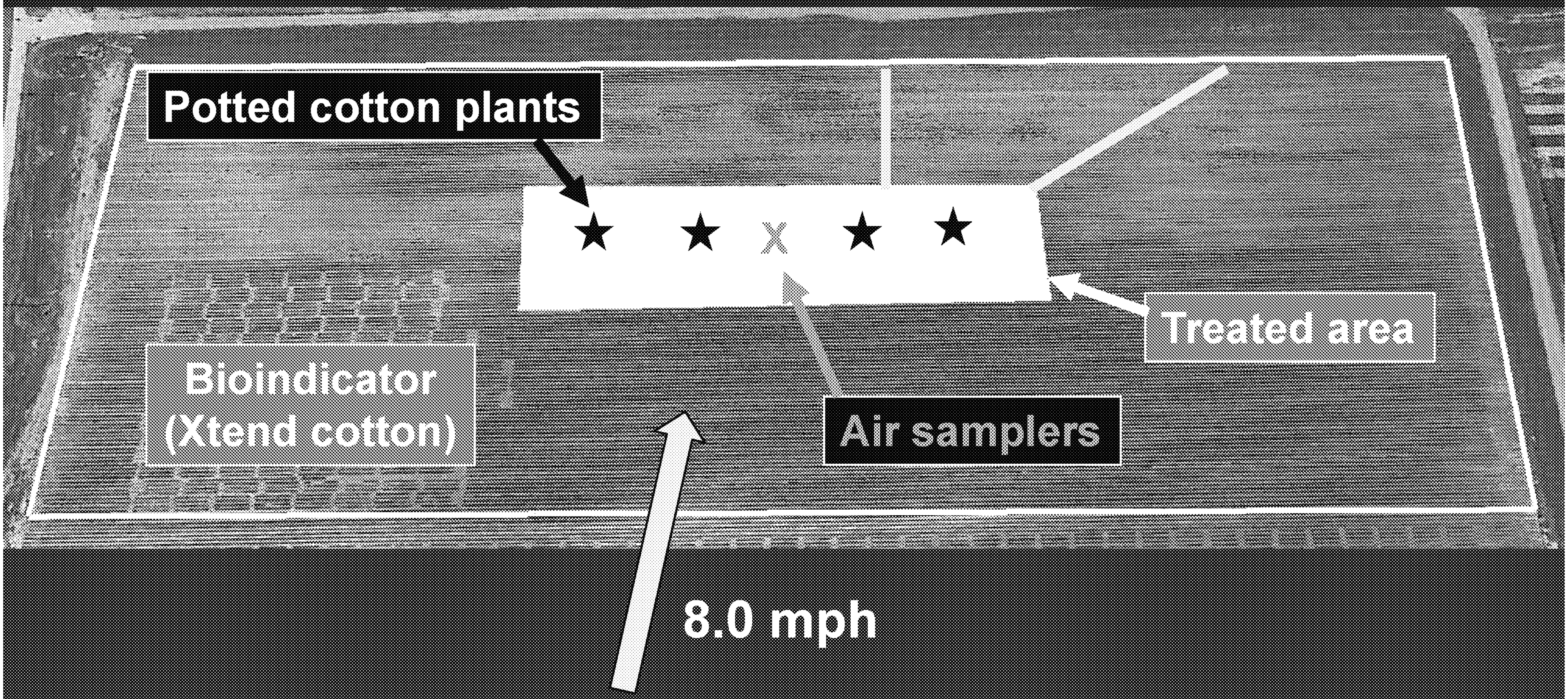
Tom Barber, Jeremy Ross, & Cammy Willett

UNIVERSITY OF ARKANSAS
DIVISION OF AGRICULTURE

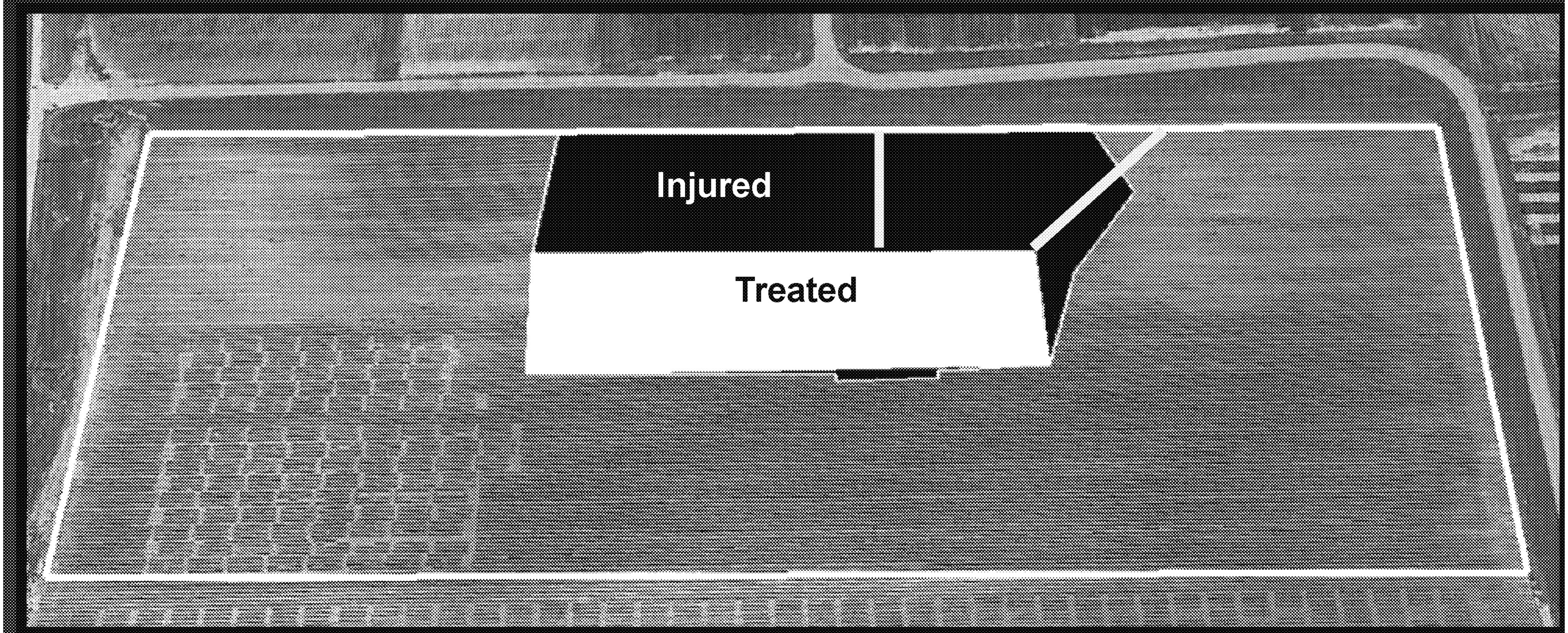
UNIVERSITY OF ARKANSAS
DIVISION OF AGRICULTURE

- Objective: Assess the likely causes for off-target movement of Enlist One with a commercial application
- Cotton: XtendFlex
- Application: 1 qt/A Enlist One + 1 qt/A Liberty
- Date: August 6, 2018 (1:55 to 2:05 PM)
- Sprayer setup
  - 25 ft boom; 8 mph; 10 GPA, 24 inch height
  - AIXR 11003 nozzles
- Environmental conditions during application
  - Avg. 8.0 mph; Range of 7.0 to 9.5 mph
  - 89 F and 54% RH

Enlist One Drift Trial
(Field Setup)



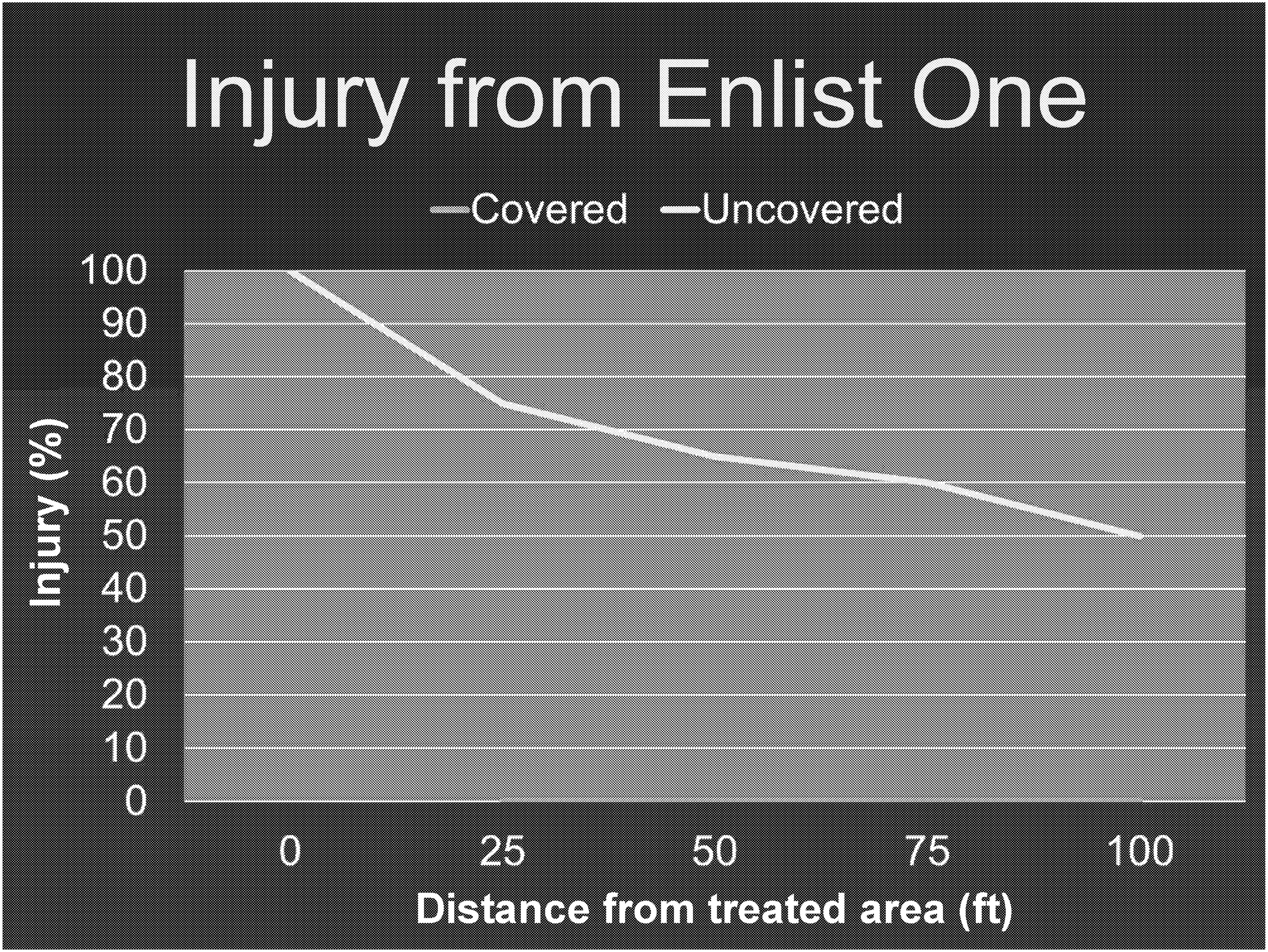
Injury to Cotton

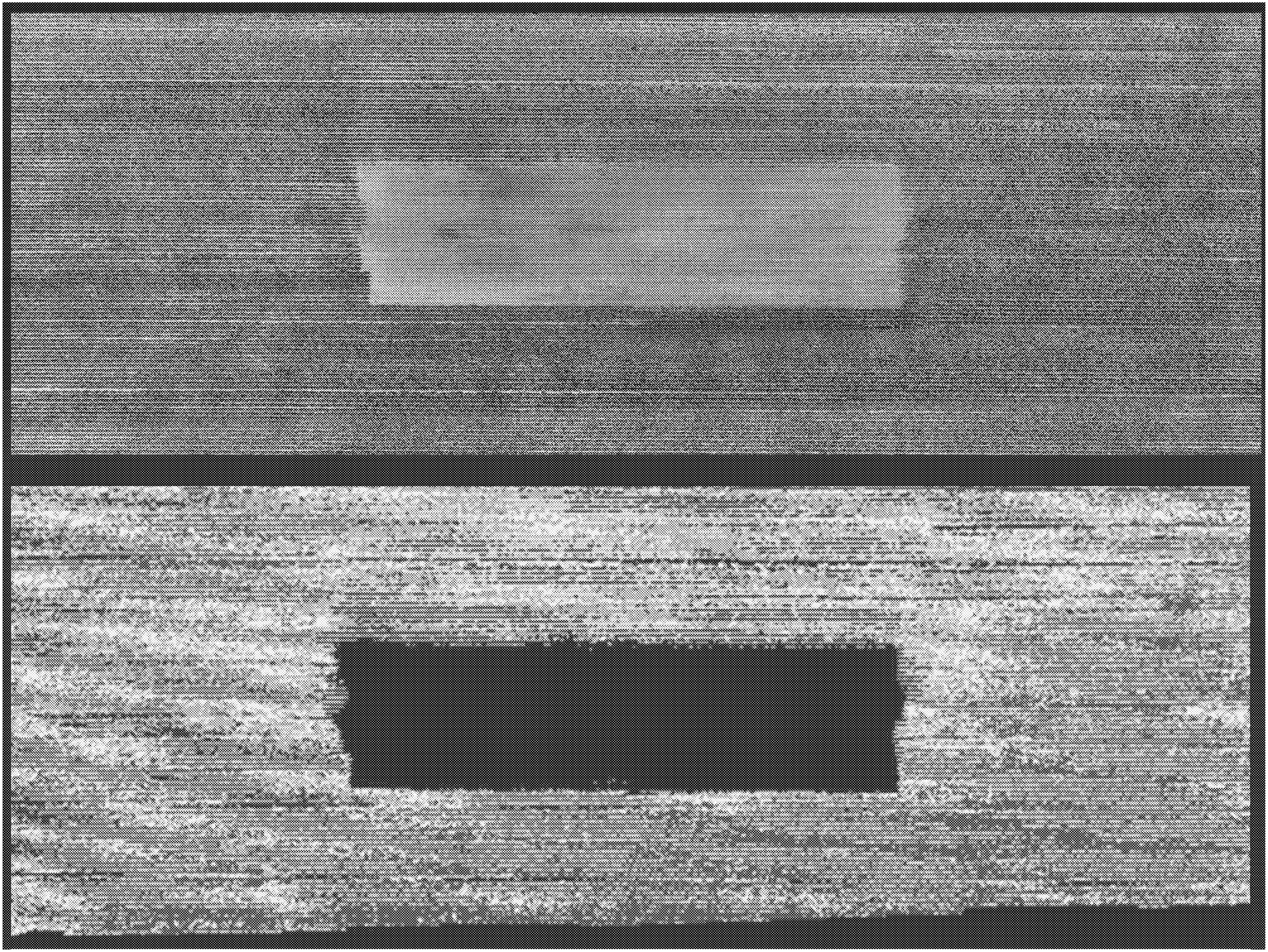


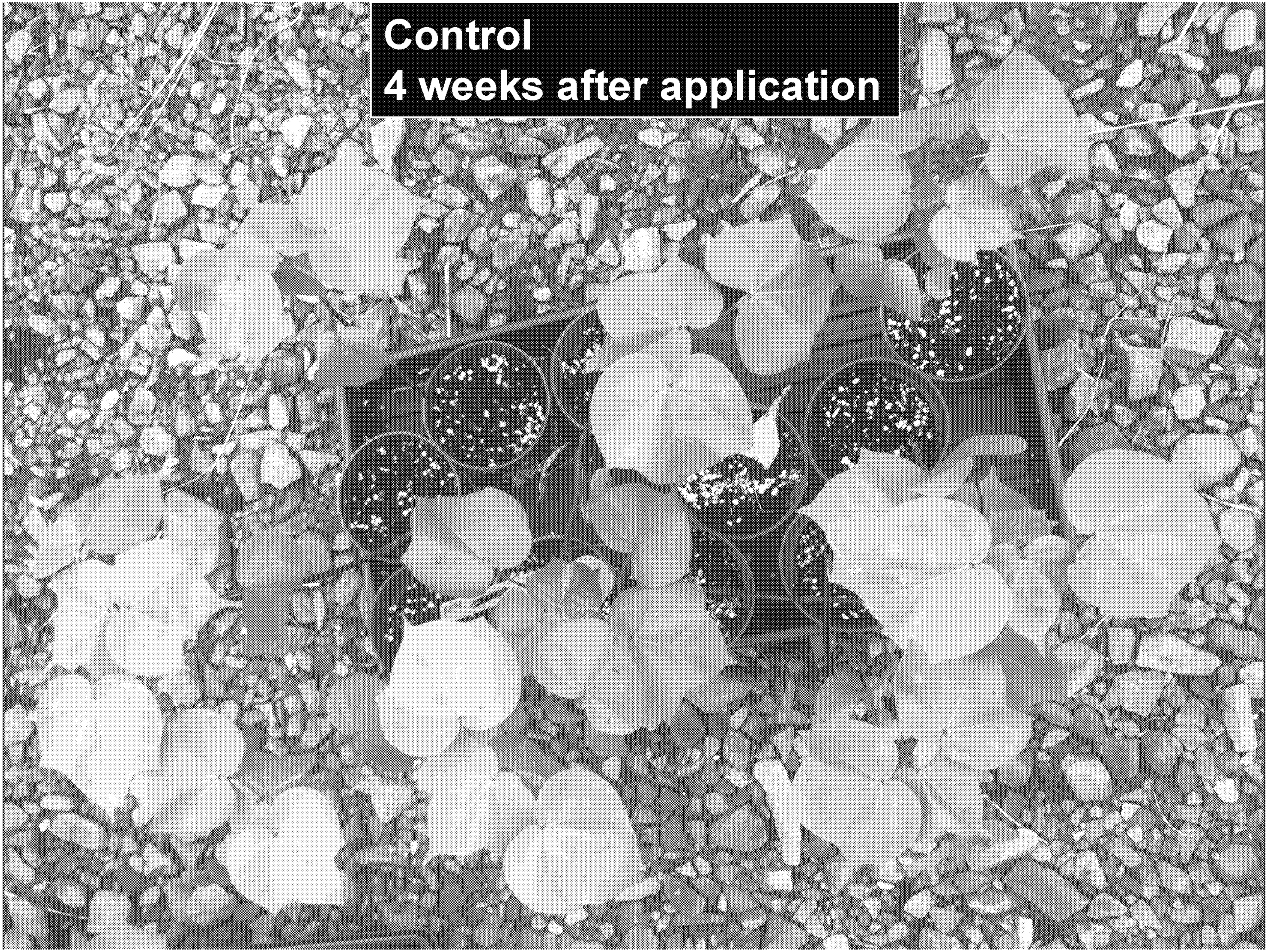
29 days after application

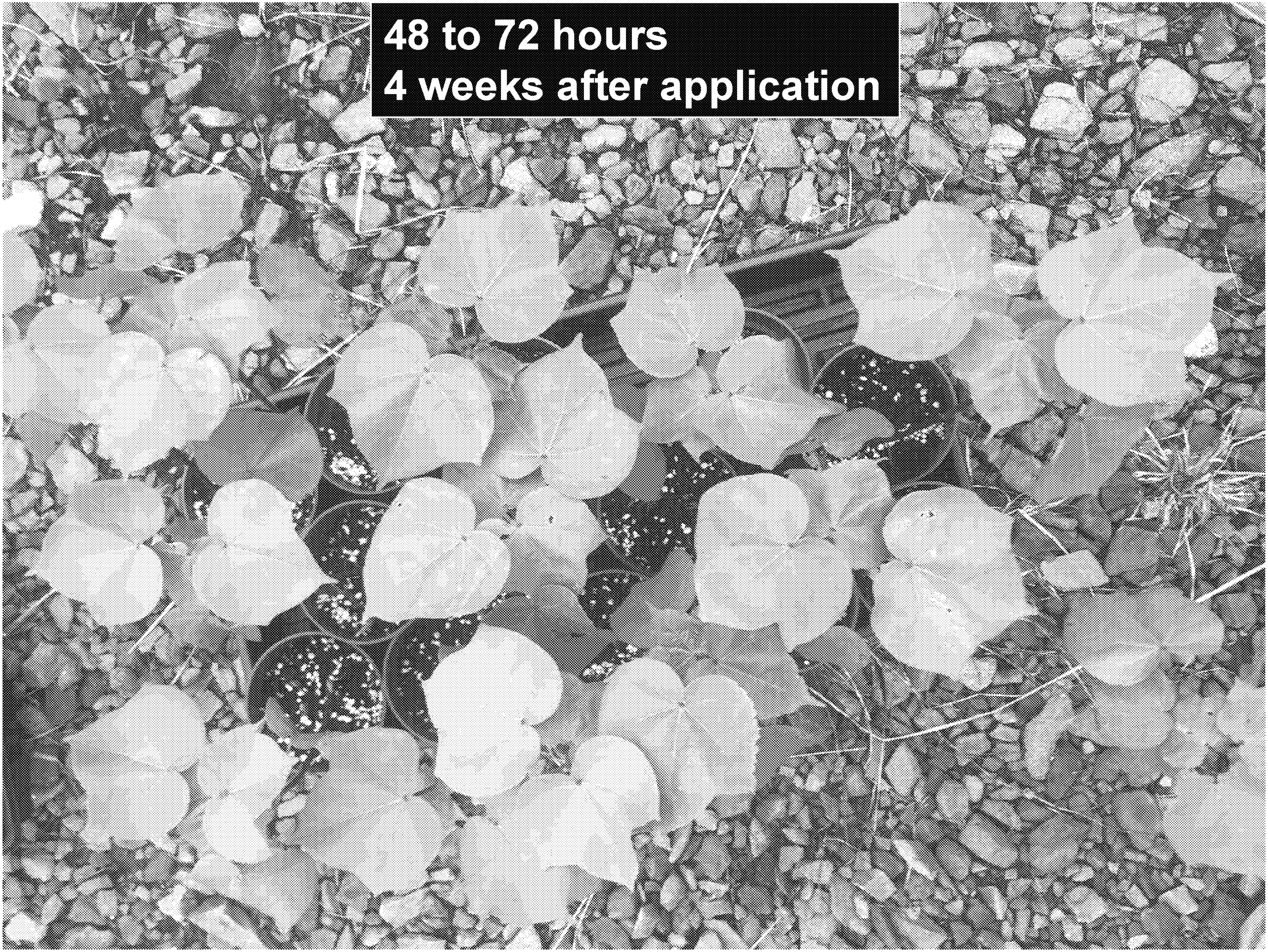

East

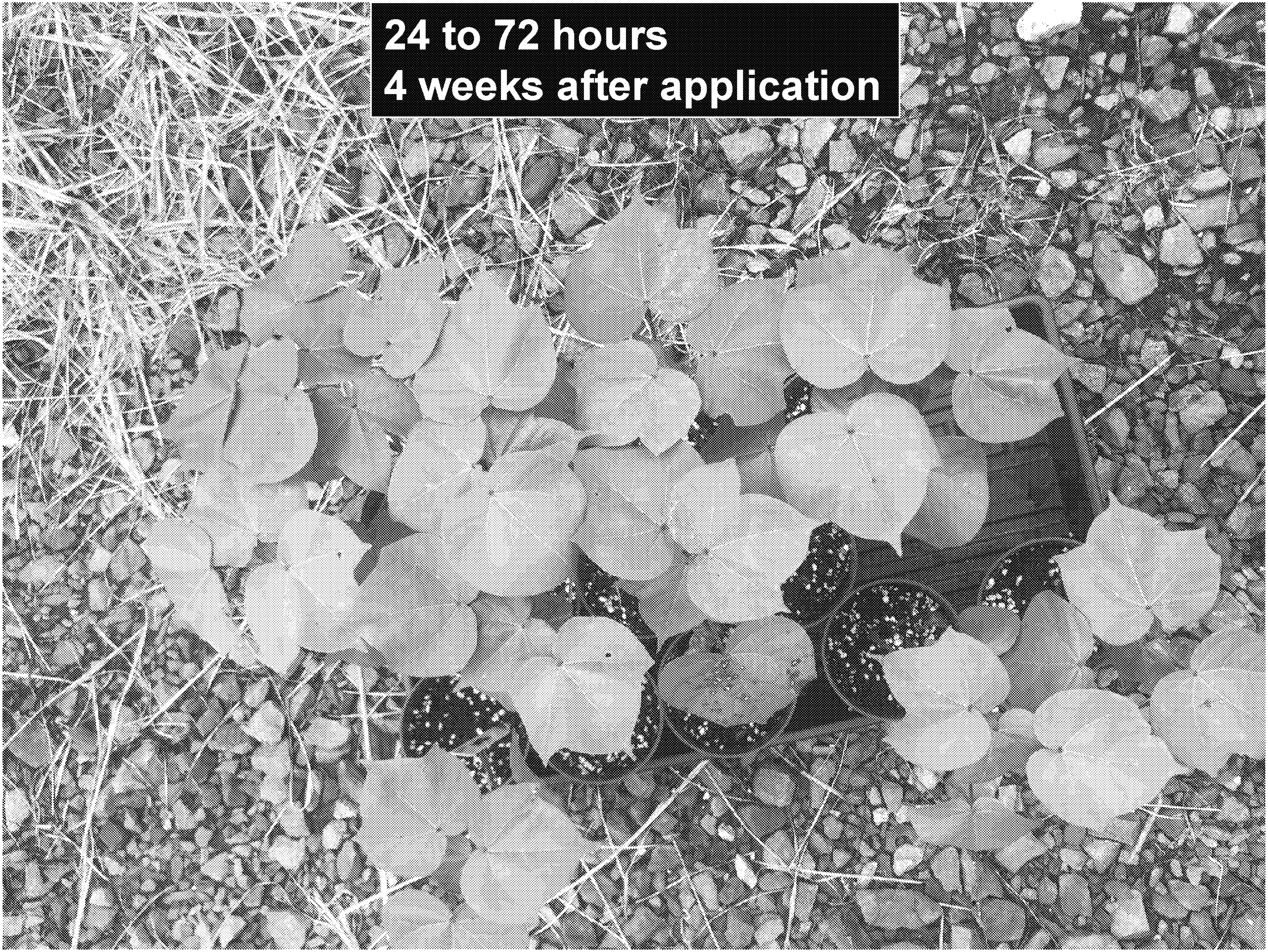

South

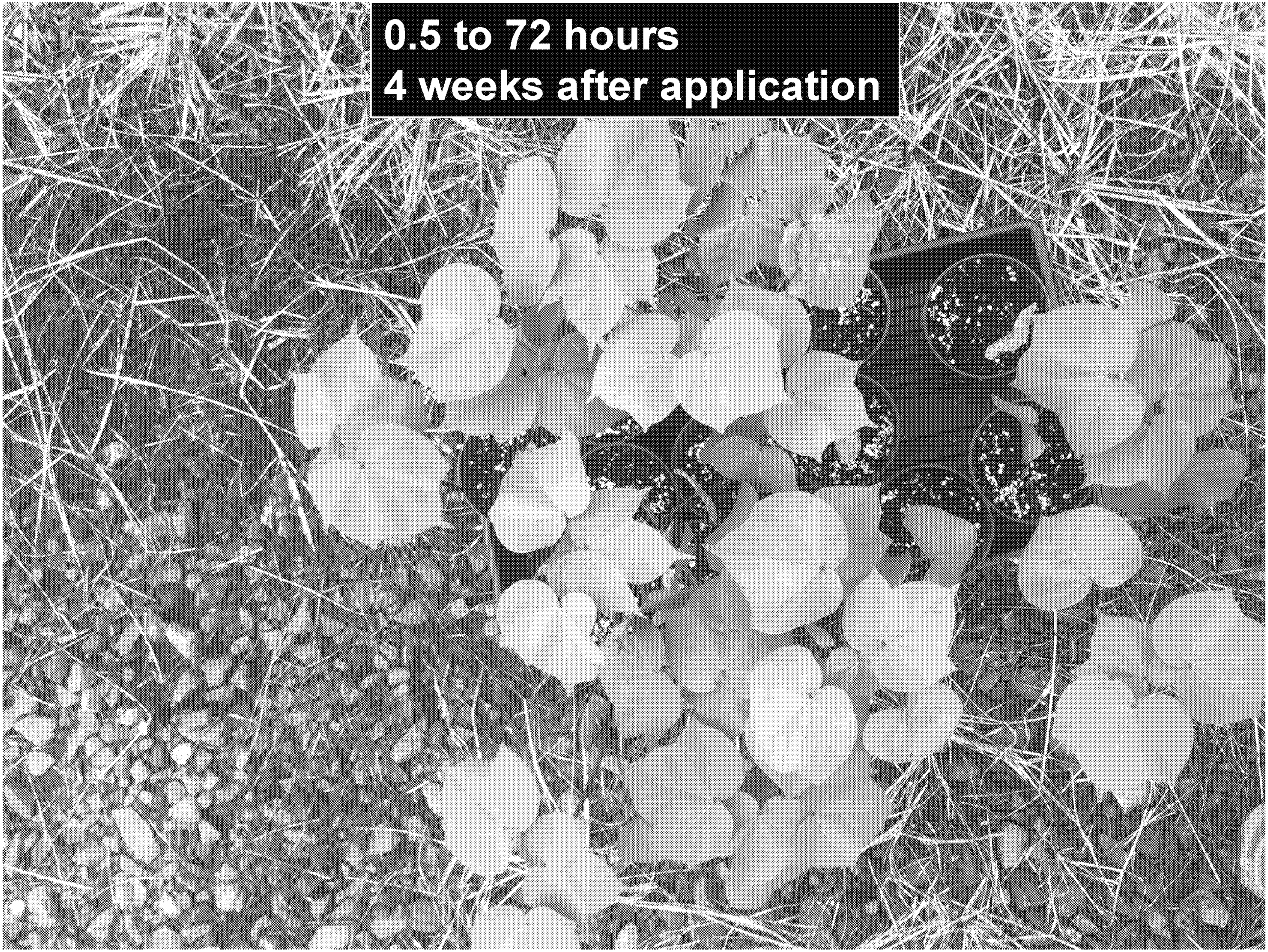

Injury from Enlist One
Covered
Uncovered
100
90
80
70
60
50
40
30
20
10
0
Injury (%)
0
25
50
75
100
Distance from treated area (ft)



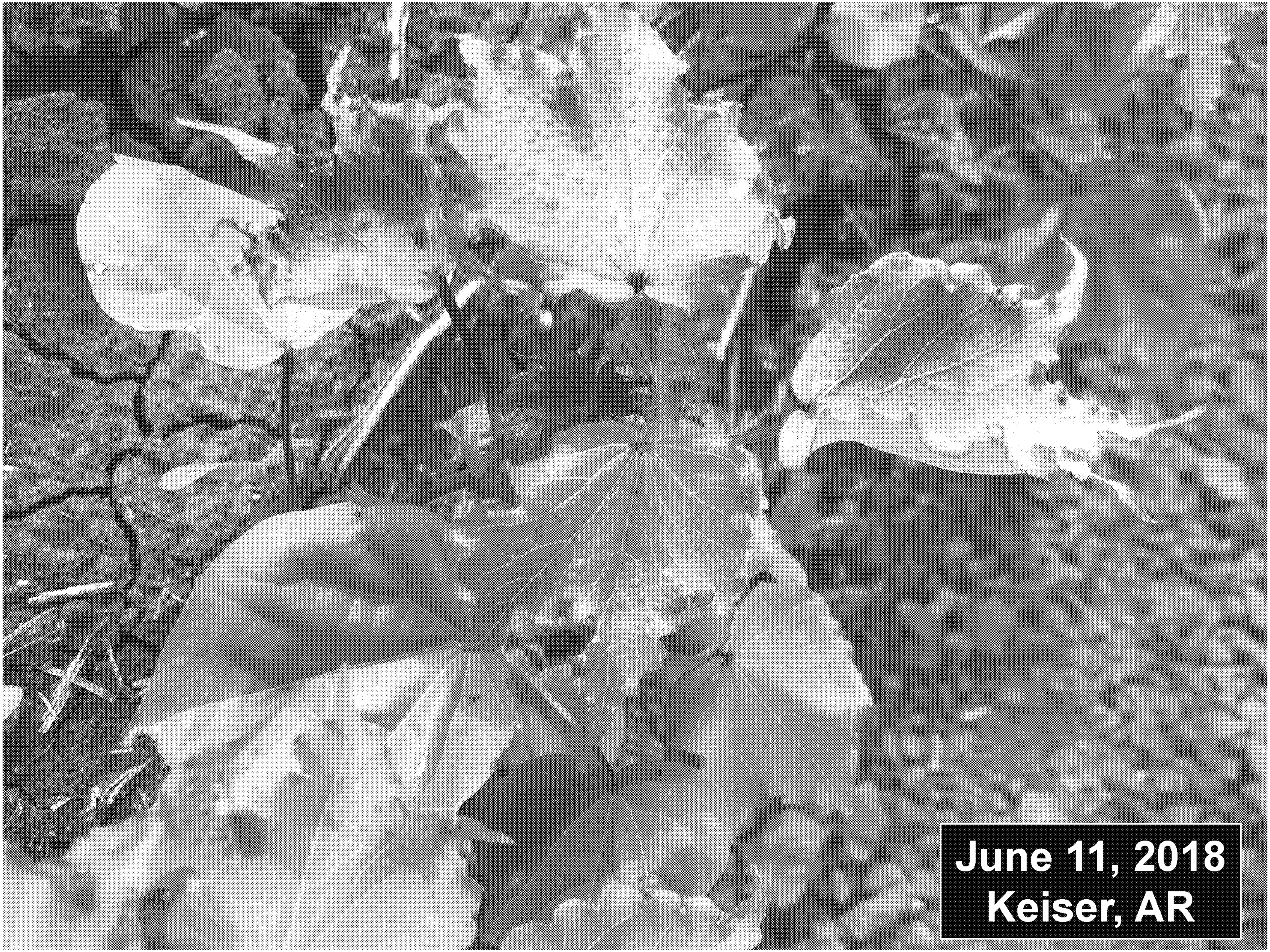

Control
4 weeks after application


48 to 72 hours
4 weeks after application


24 to 72 hours
4 weeks after application


0.5 to 72 hours
4 weeks after application


Objective: Assess the ability of the See-and-Spray system to control weeds and reduce off-target movement of dicamba

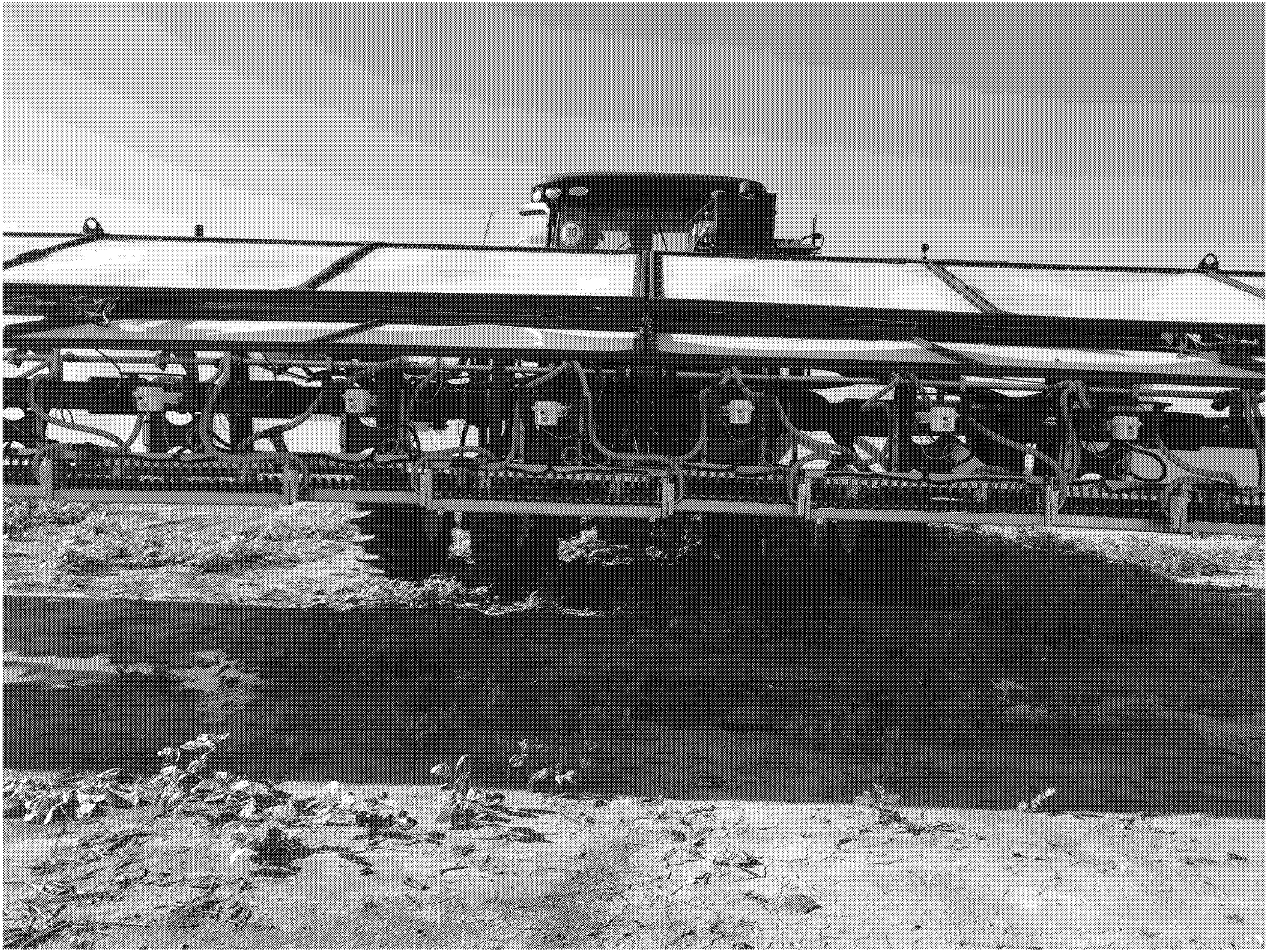

June 11, 2018
Keiser, AR

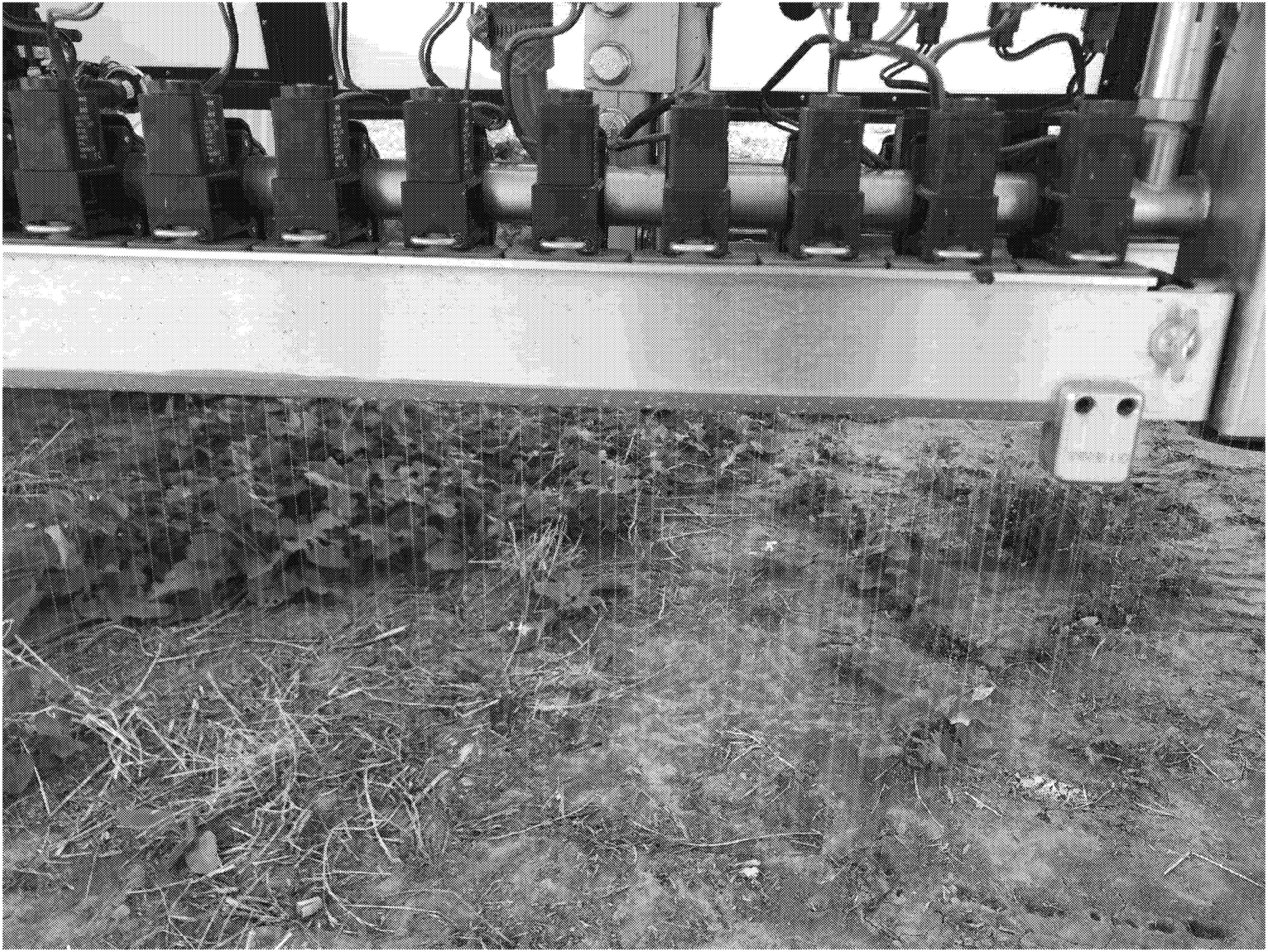
- Objective: Assess the ability of the See-and-Spray system to reduce off-target movement of dicamba

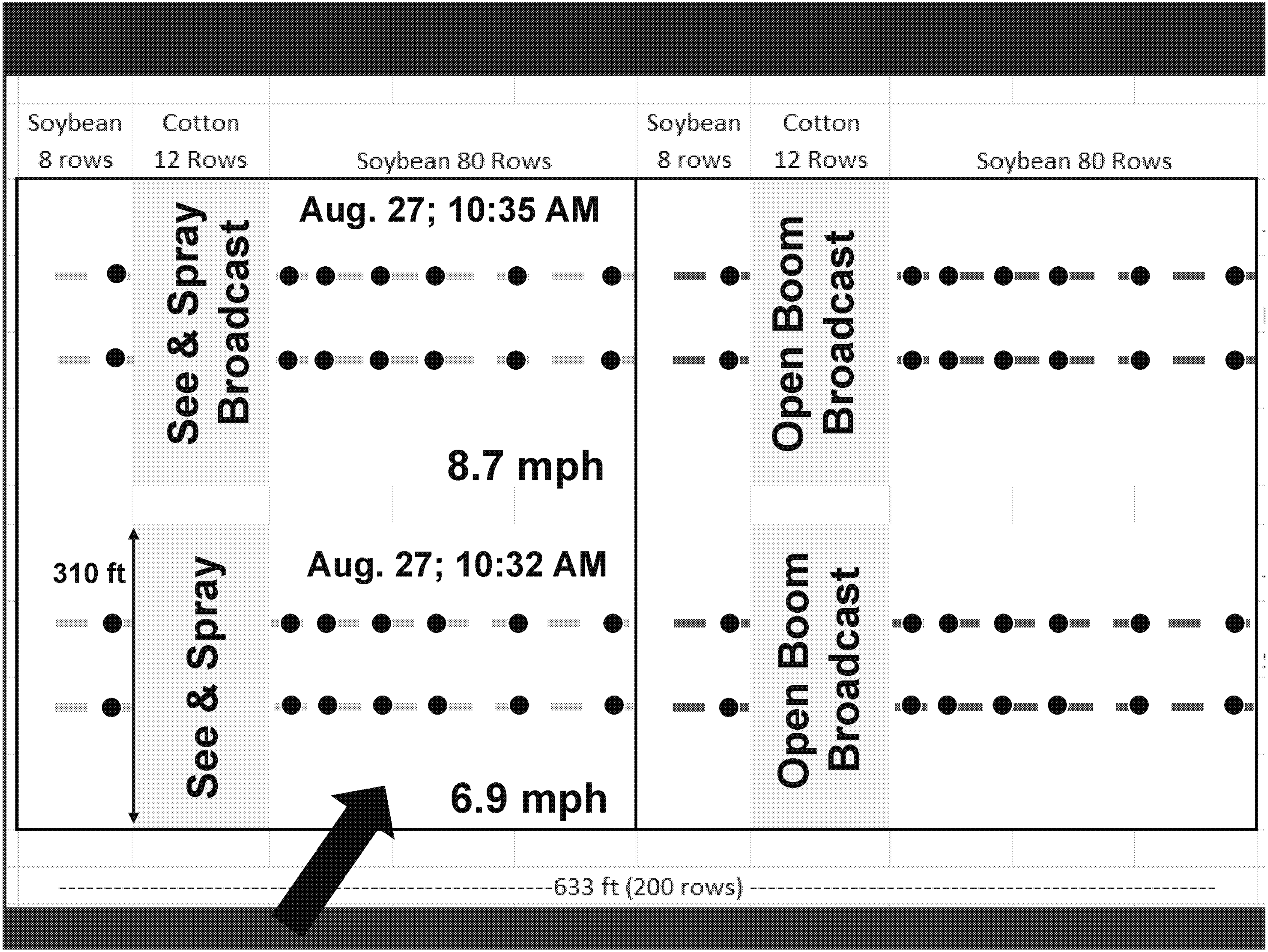
- Location: Keiser, AR

- Treatments:
  - Open boom broadcast vs. See-and-Spray hooded boom broadcast
  - Open boom broadcast vs. See-and-Spray

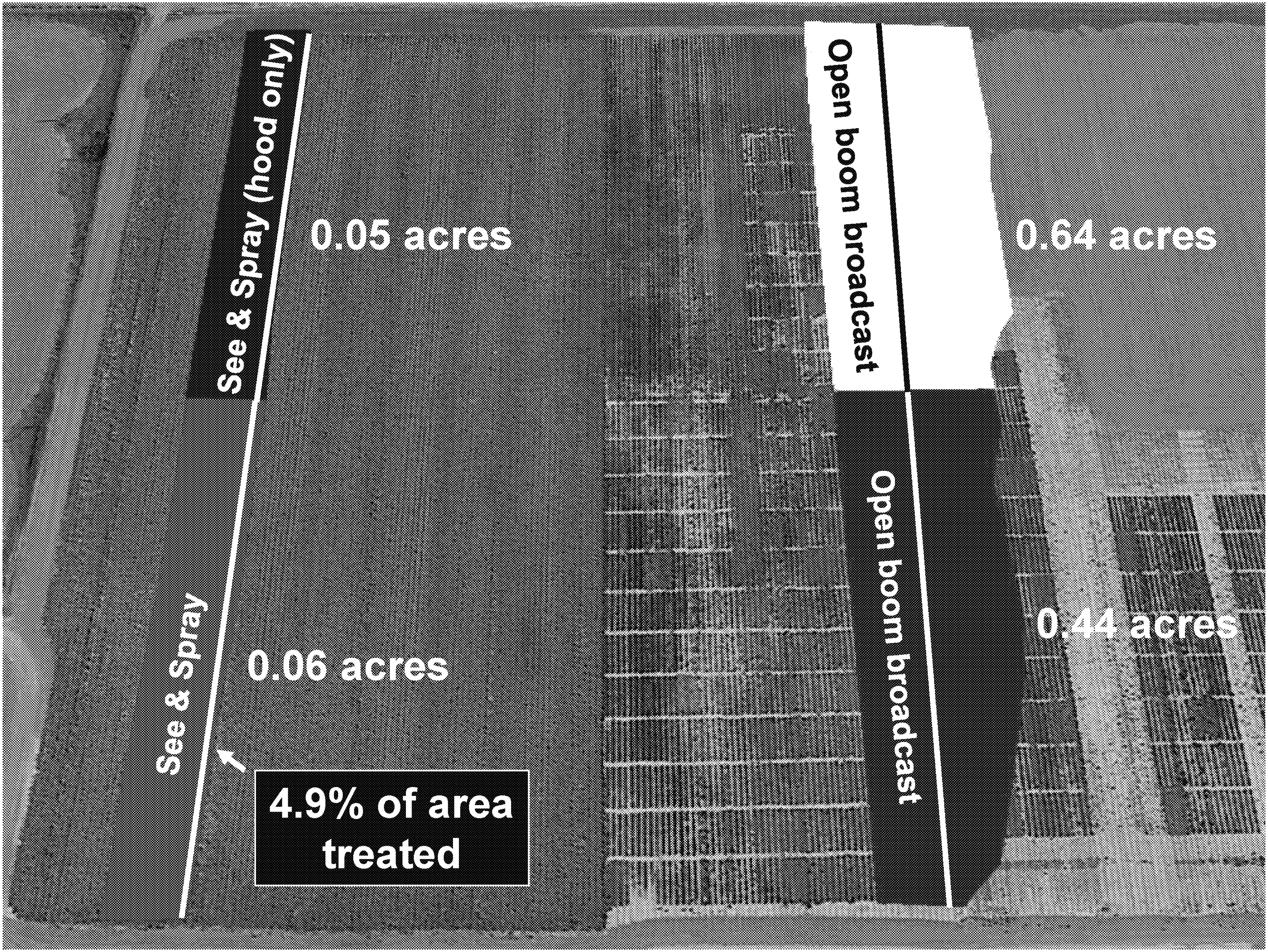
- Engenia + Roundup PowerMax + Intact







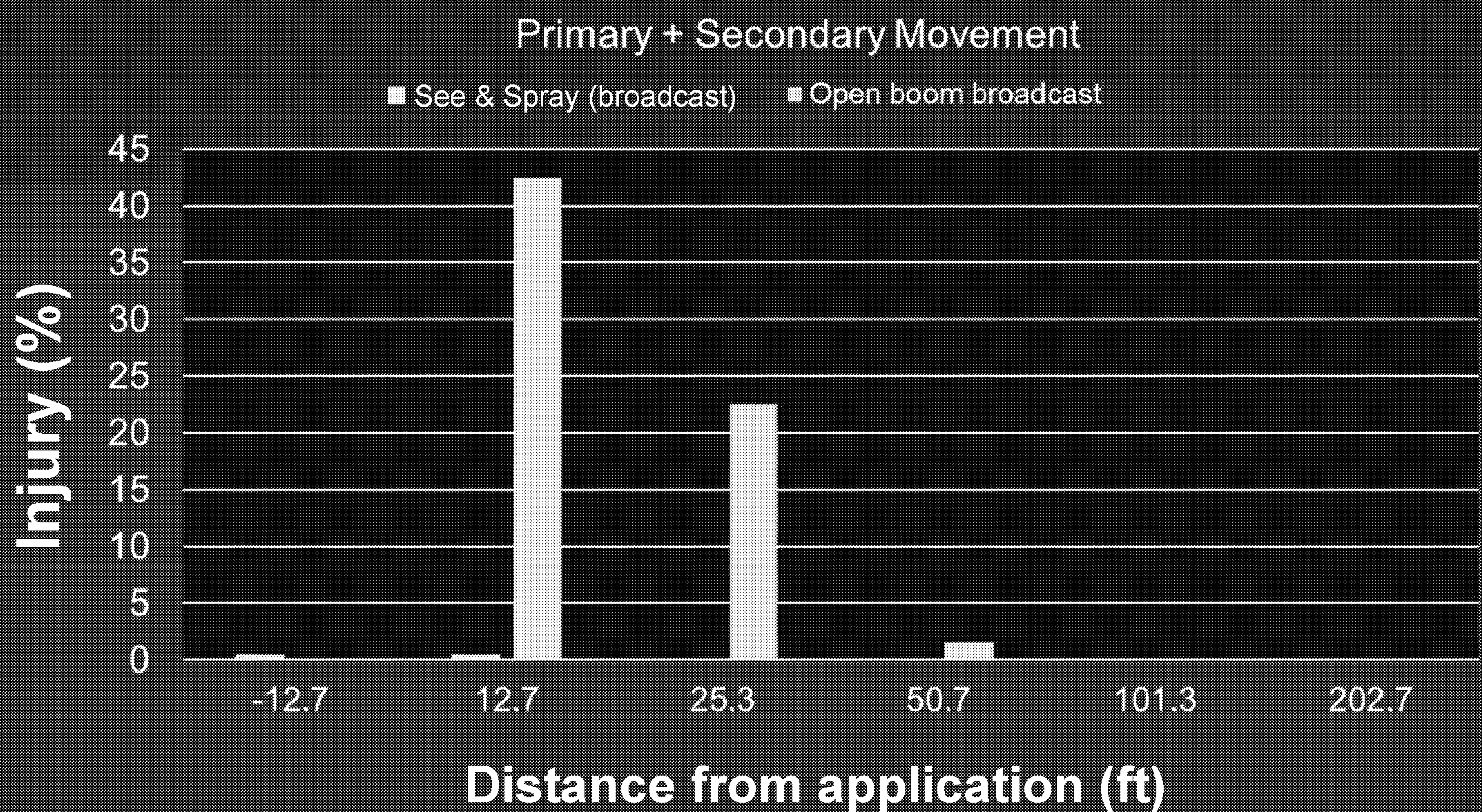
Soybean 8 rows
Cotton 12 Rows
Soybean 80 Rows
Soybean 8 rows
Cotton 12 Rows
Soybean 80 Rows
See & Spray Broadcast
Aug. 27; 10:35 AM
8.7 mph
Open Boom Broadcast
310 ft
See & Spray
Aug. 27; 10:32 AM
6.9 mph
Open Boom Broadcast
633 ft (200 rows)



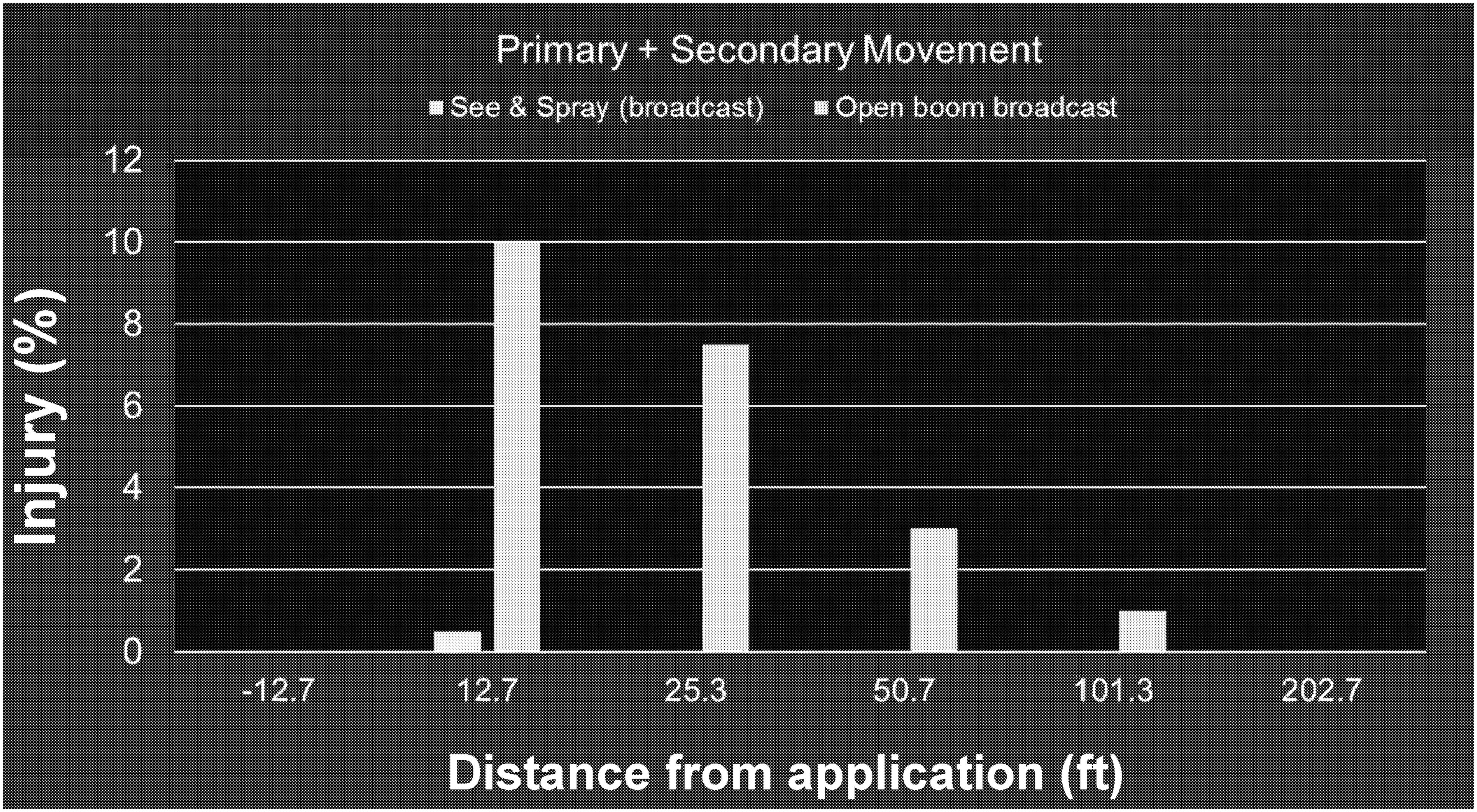
See & Spray (hood only)
0.05 acres
Open boom broadcast
0.64 acres
Open boom broadcast
0.44 acres
See & Spray
0.06 acres
4.9% of area treated


See & Spray System

See & Spray vs. Open Boom
(15 days after application)



See & Spray (Broadcast) vs. Open Boom (Broadcast)
(15 days after application)



ED_002296_00002543-00025

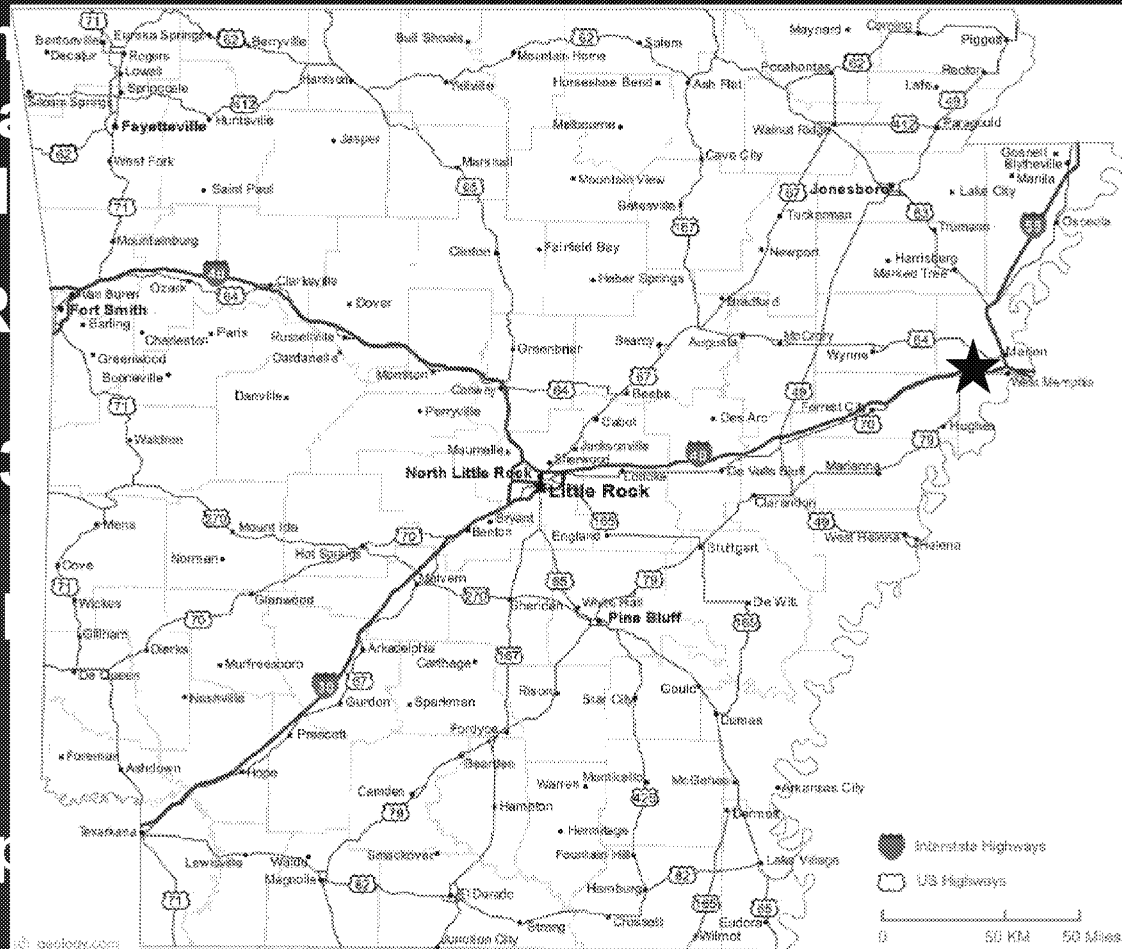
Goal: Determine the m
movement of dicamba
commercial field appl

Location: Proctor, AR

Trial size: 240 acres (3

Cooperators: Mike & I

Treatment:
XtendiMax + Roundup

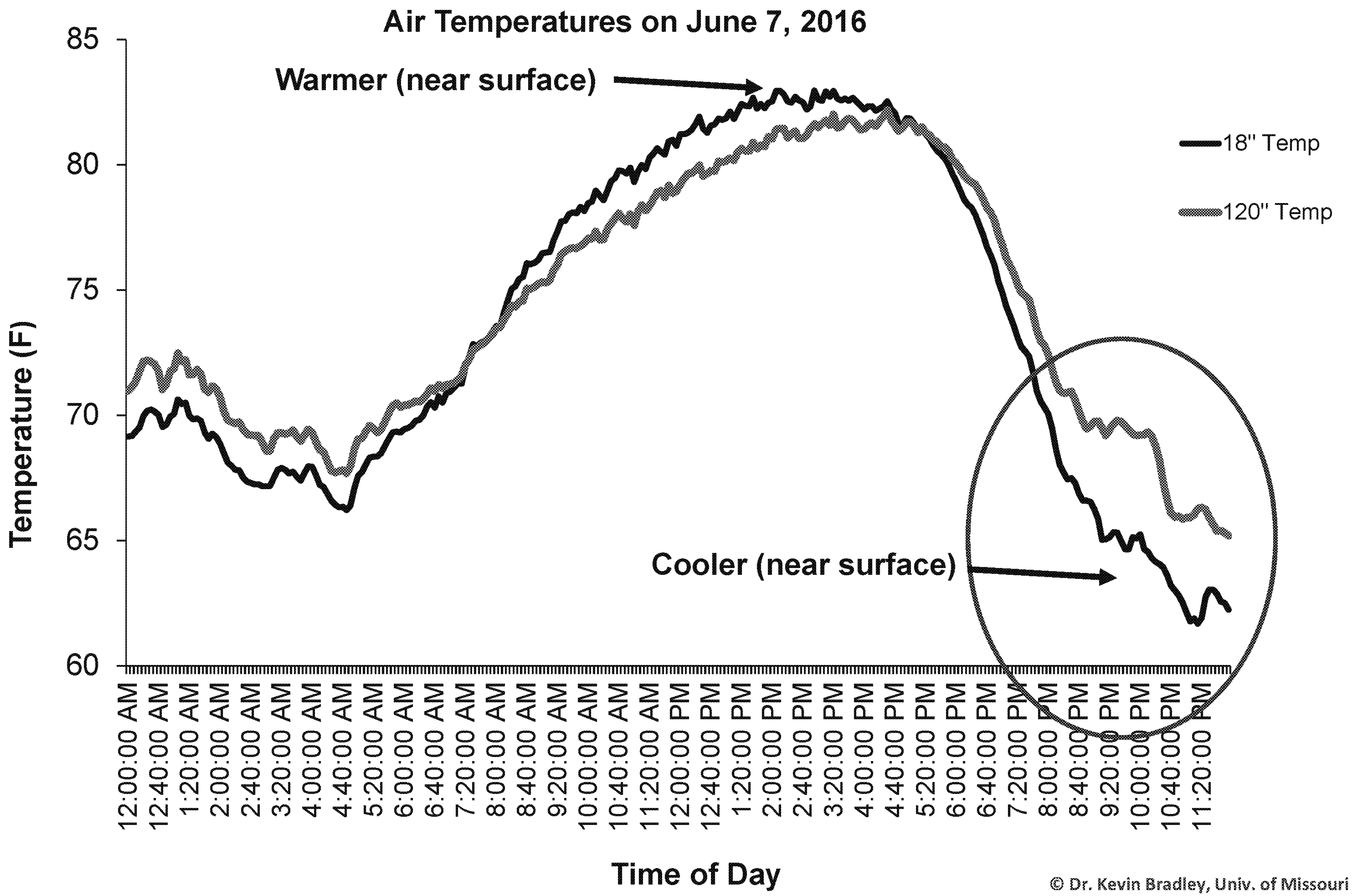


From July 9 at 1:00 PM – July 16 at 2:58 PM there were no sustained wind speeds above 3 mph for a sufficient period to spray

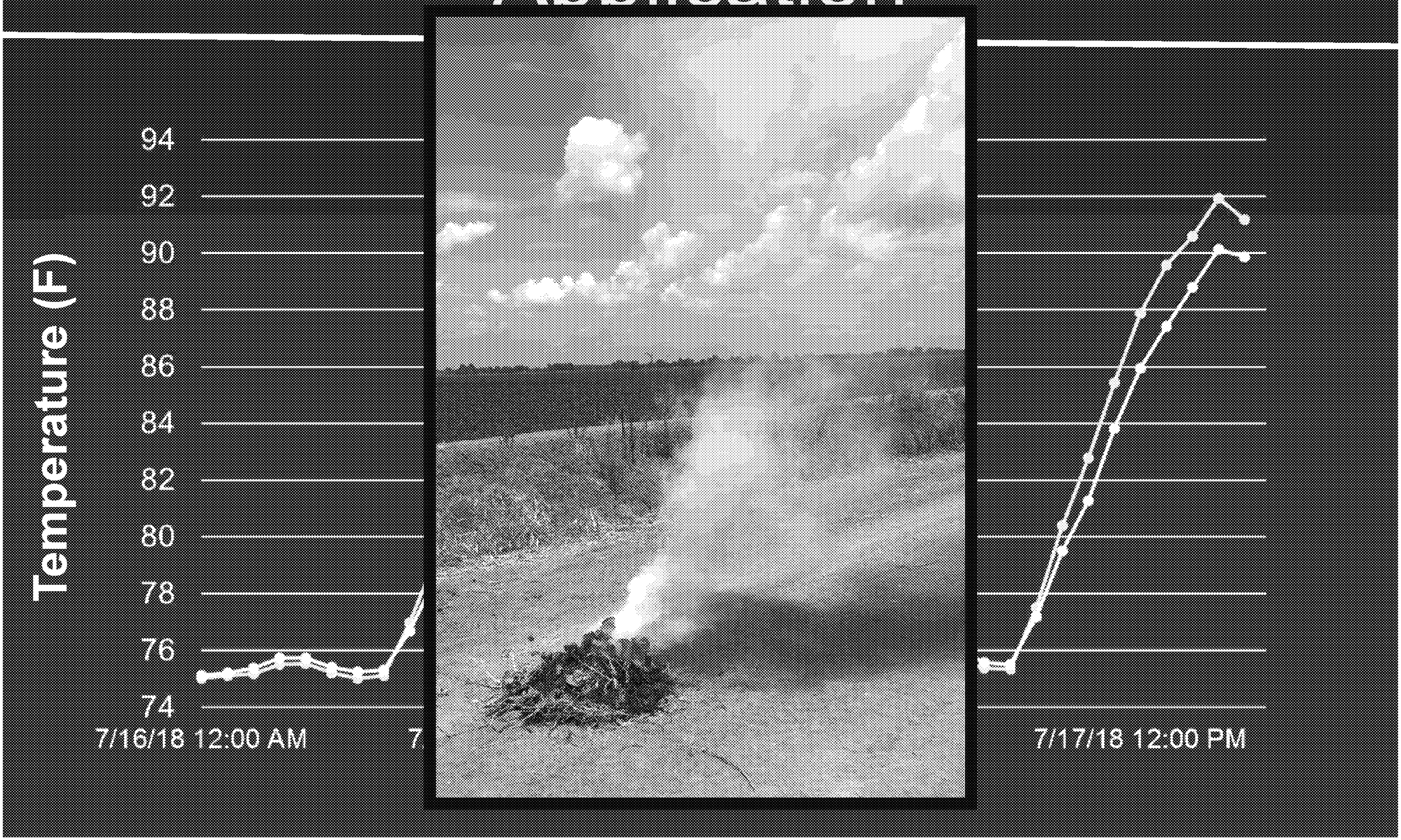
Application made July 16 at 2:58 PM


Tarp 6
Monsanto Sampler
Tarp 1
Tarp 2
Monsanto Sampler
Tarp 5
Center Mass
High Volume
Tarp 3
Tarp 4
Monsanto Sampler
© 2018 Google

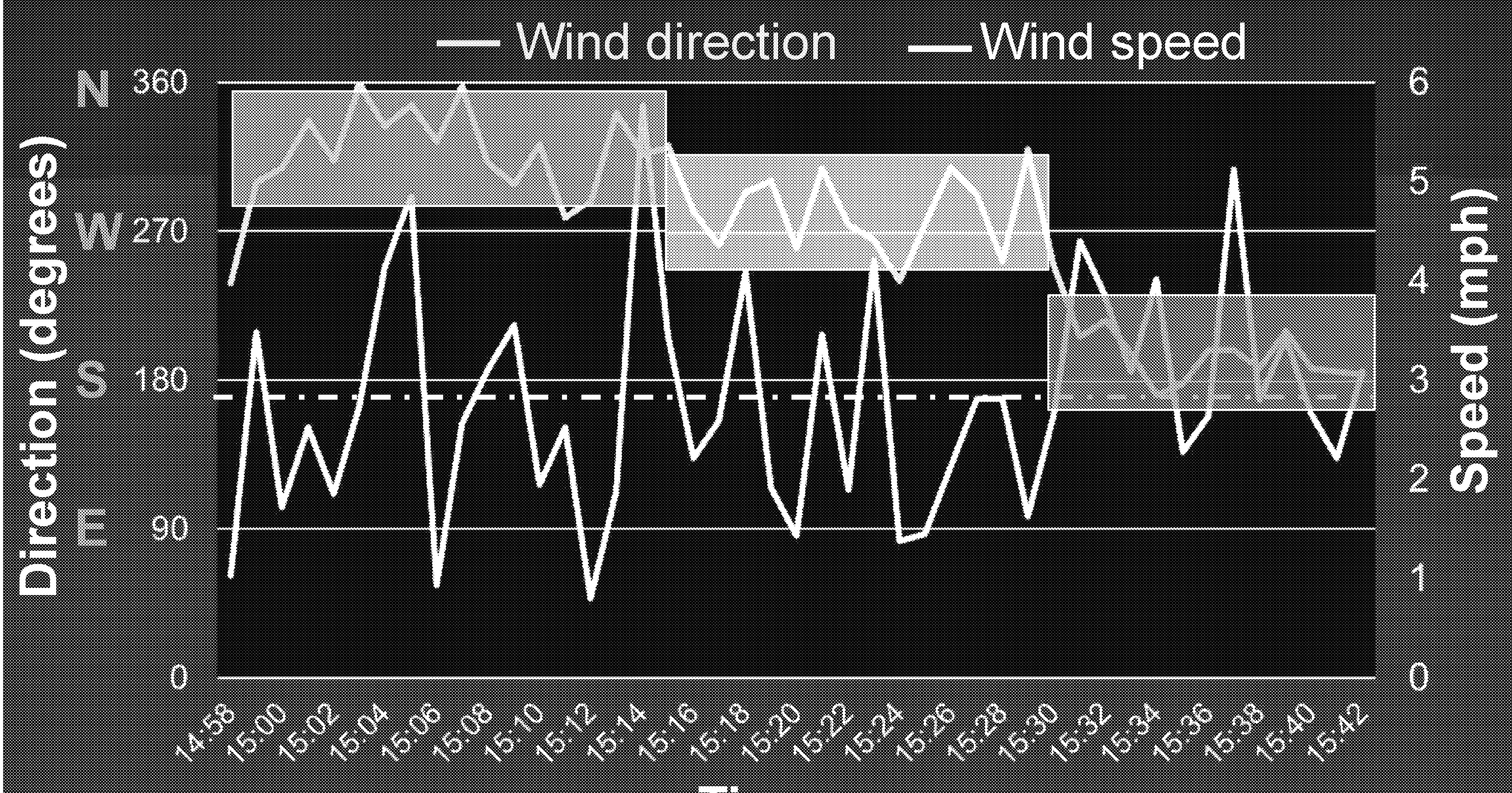
An Example Temperature Inversion in Southeast Missouri in 2016

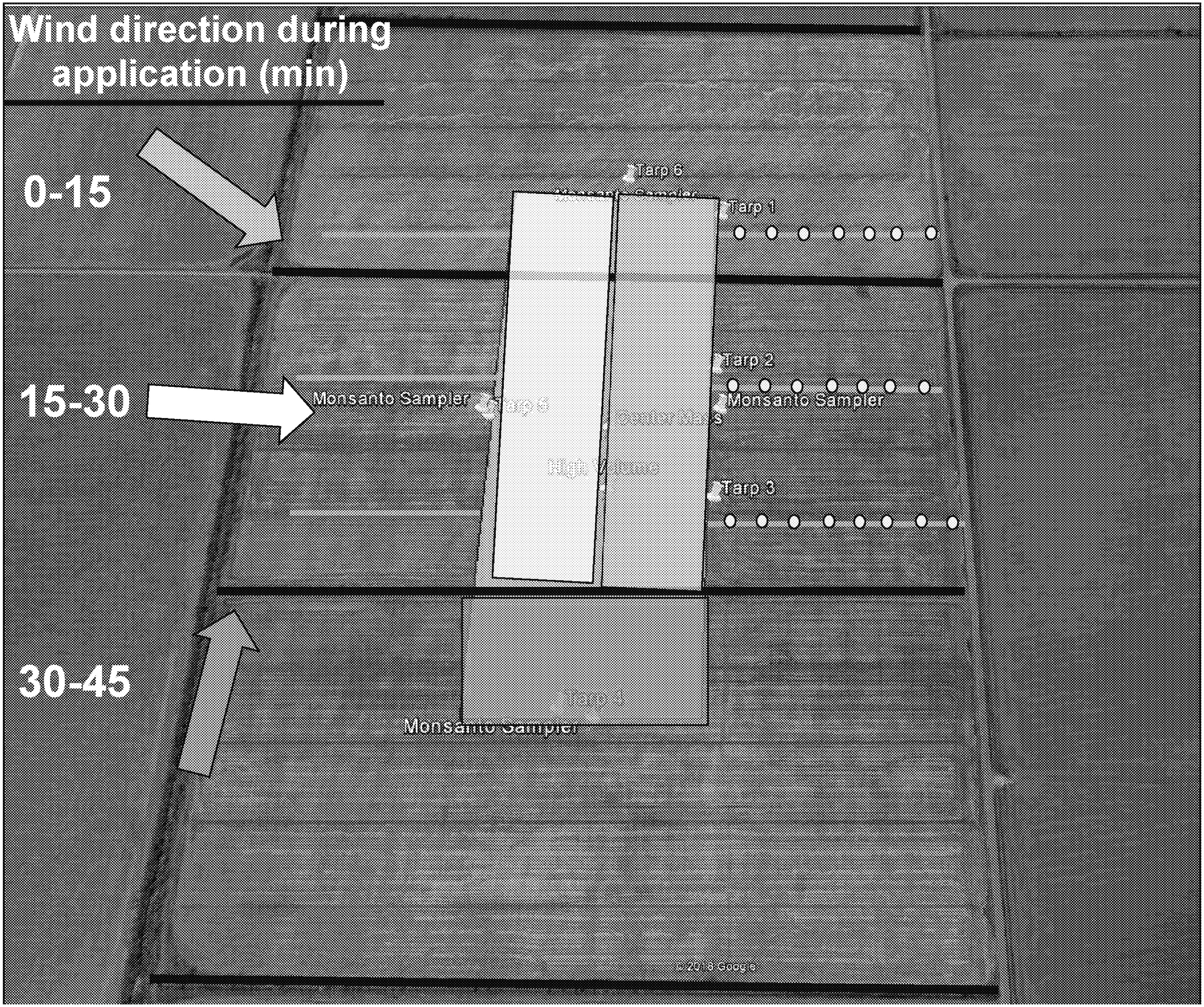


Temperature During and After Application

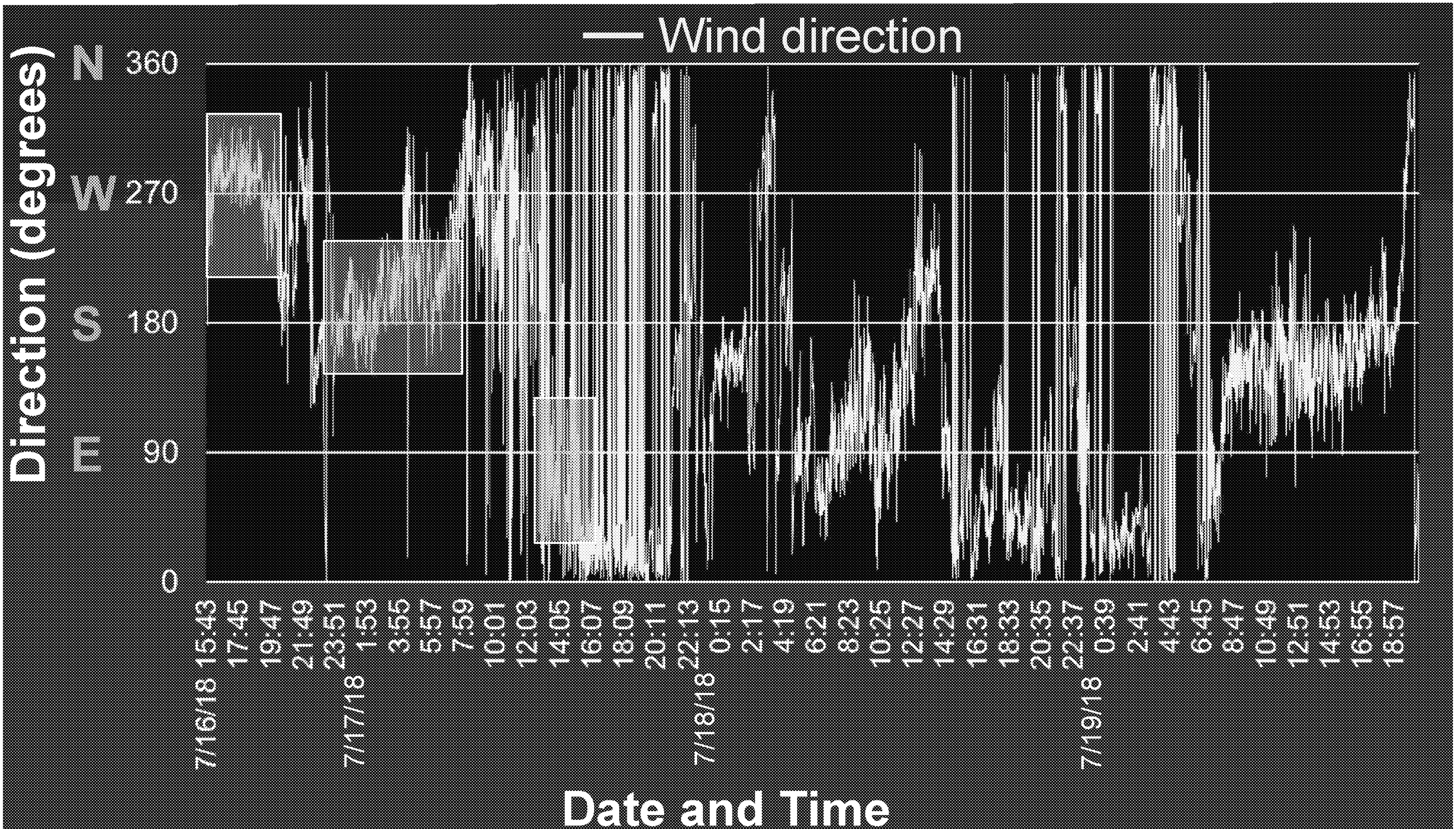


Wind Direction and Speed During Application at Boom Height

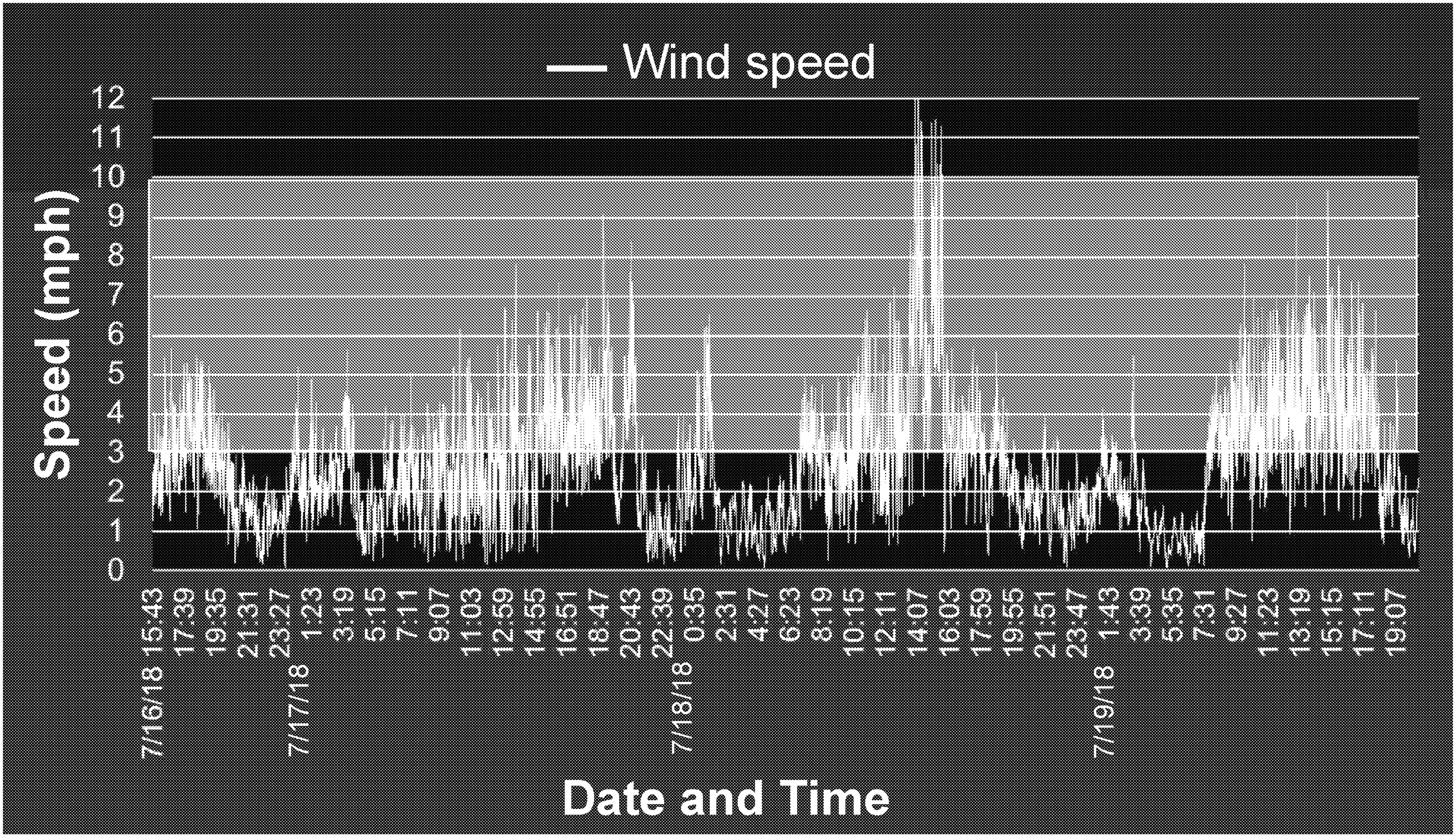



Wind direction during application (min)
0-15
15-30
30-45
Tarp 6
Tarp 1
Tarp 2
Monsanto Sampler
Monsanto Sampler
Tarp 3
High Volume
Monsanto Sampler
© 2018 Google

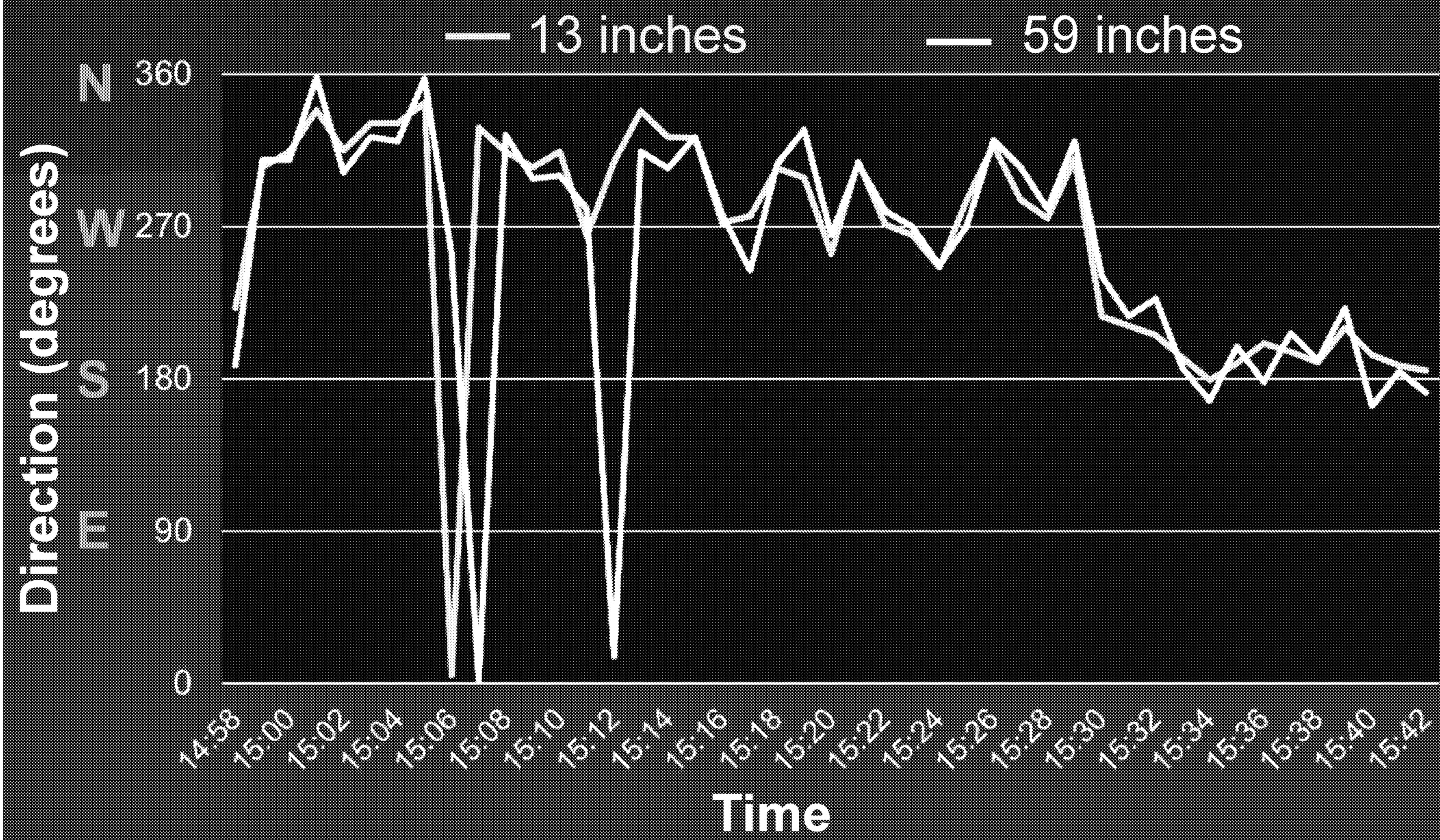
Wind Direction Following Application at Boom Height

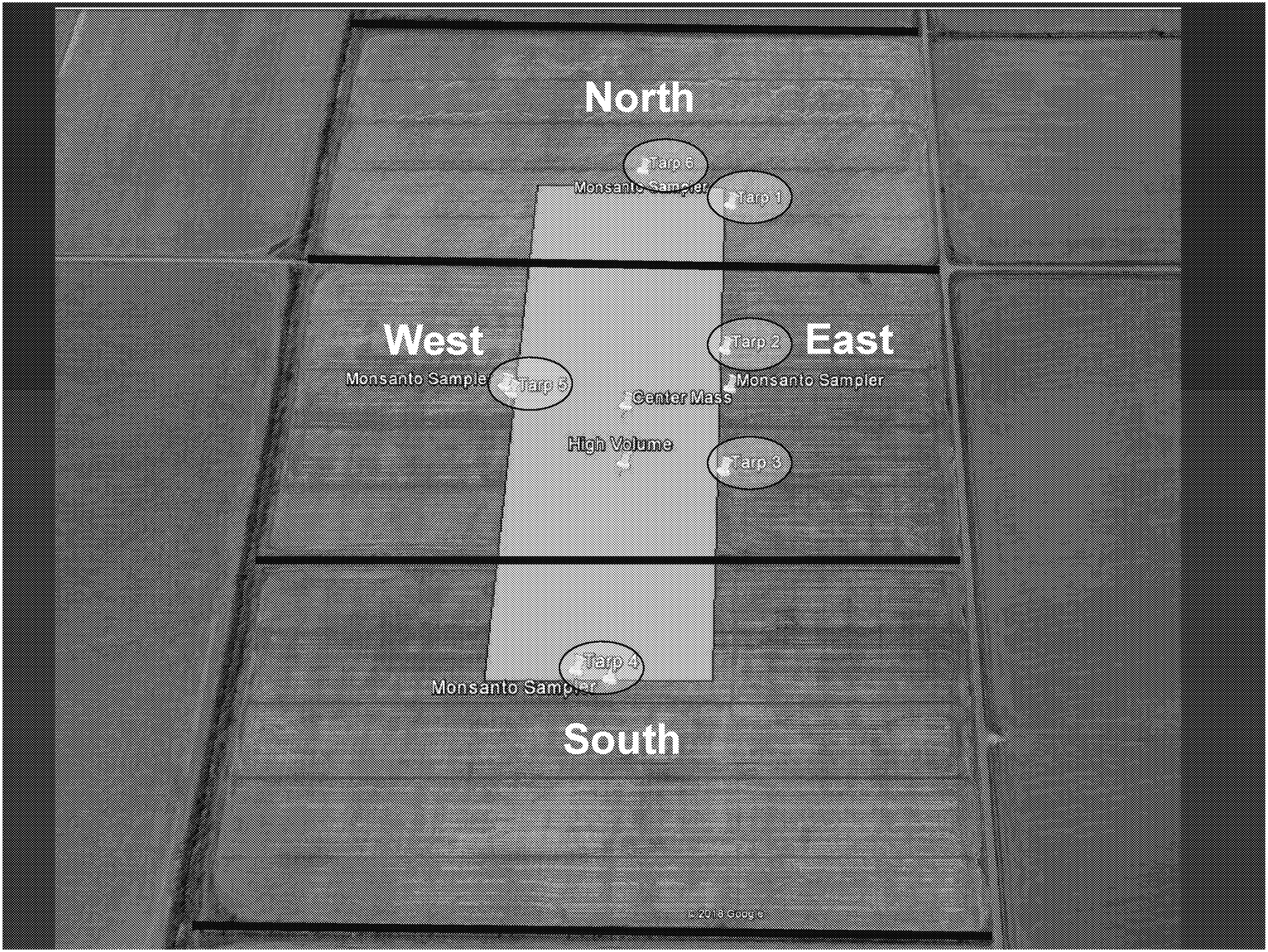


Wind Speed Following Application at Boom Height



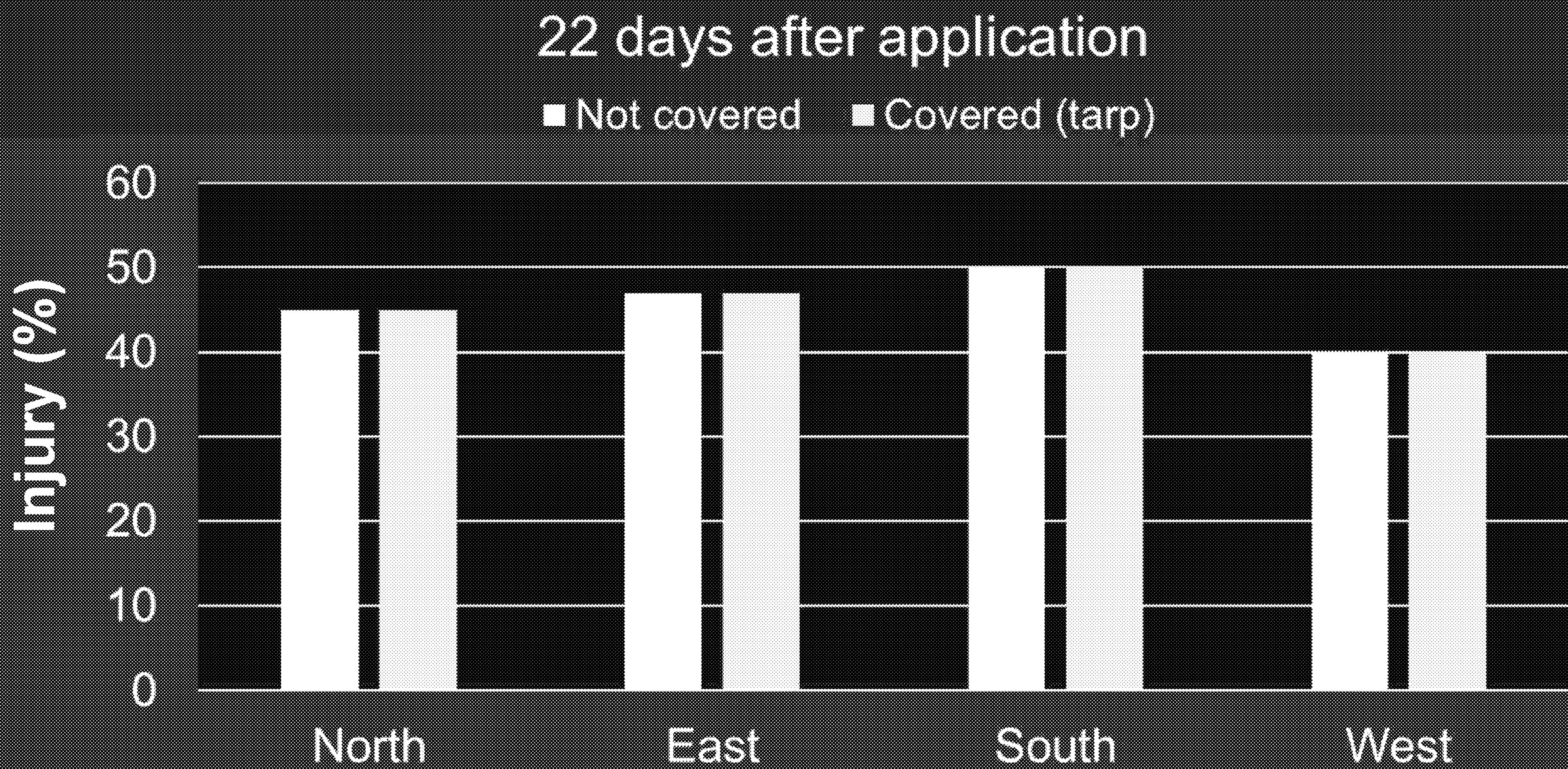
Wind Direction at Two Heights During Application

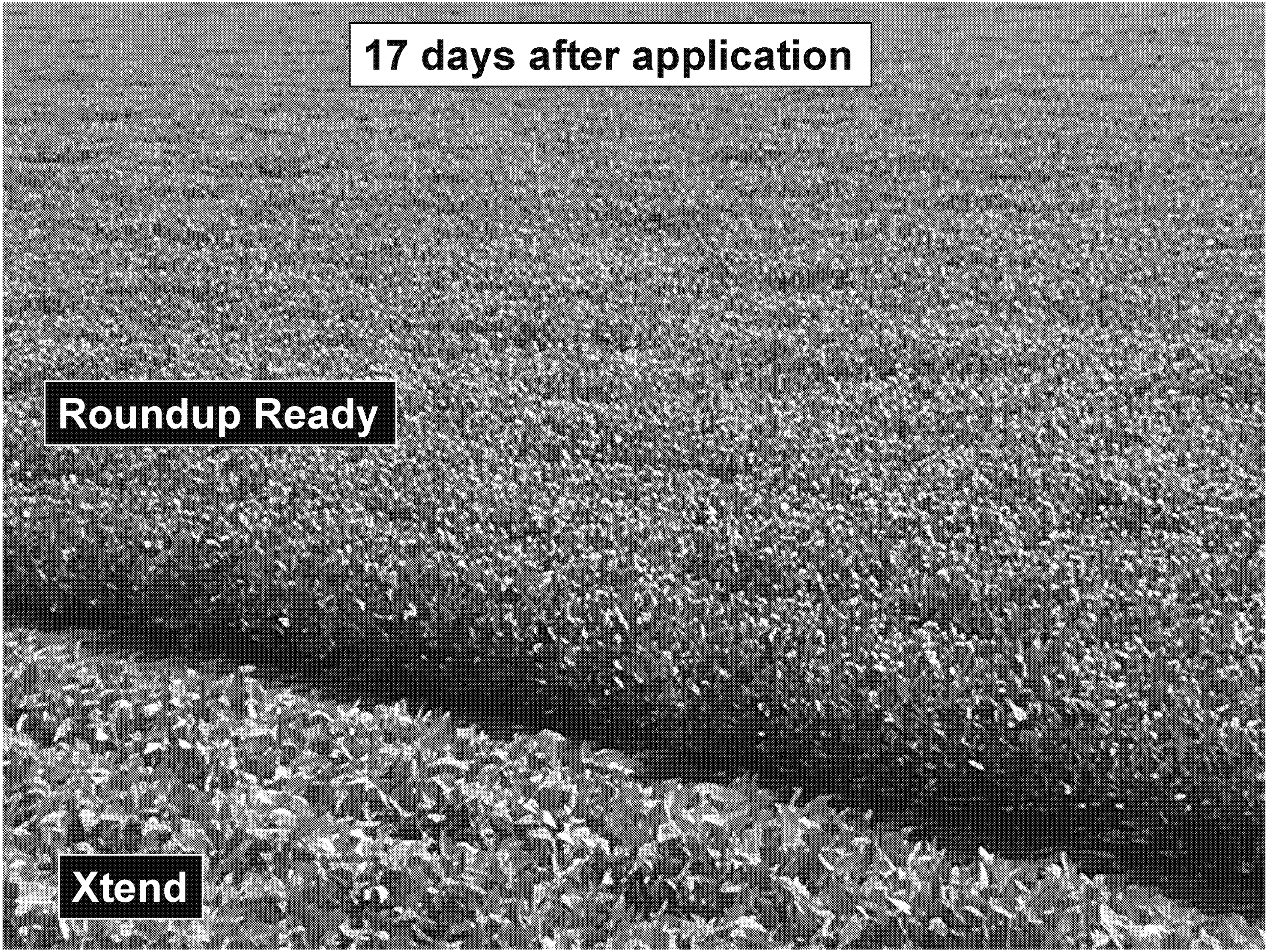


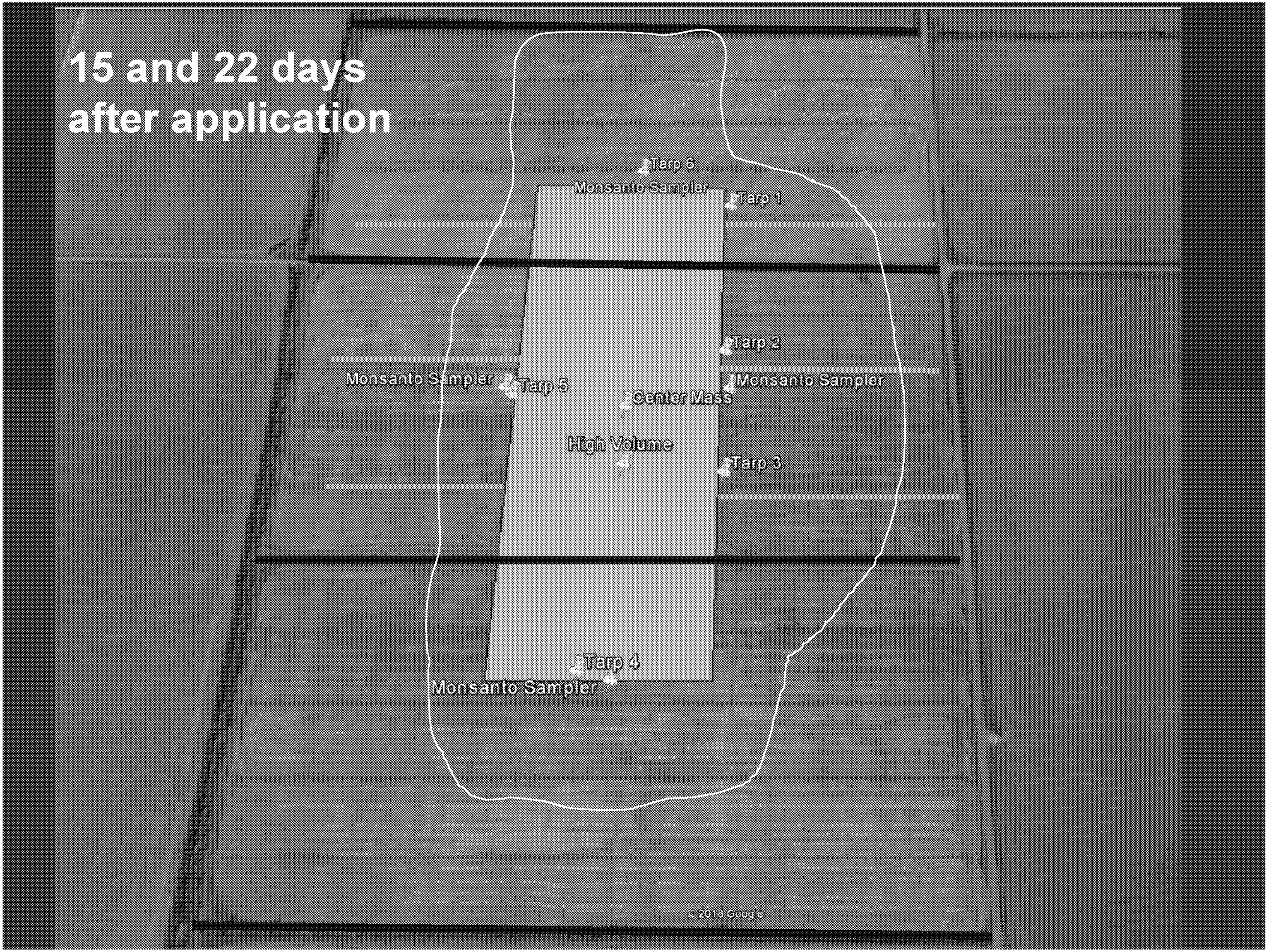

North
Tarp 6
Monsanto Sampler
Tarp 1
West
Tarp 2
East
Monsanto Sample
Tarp 5
Monsanto Sampler
Center Mass
High Volume
Tarp 3
Tarp 4
Monsanto Sampler
South
© 2018 Google


Tarp Covered Soybean Outside Treated Area
Not covered
Covered

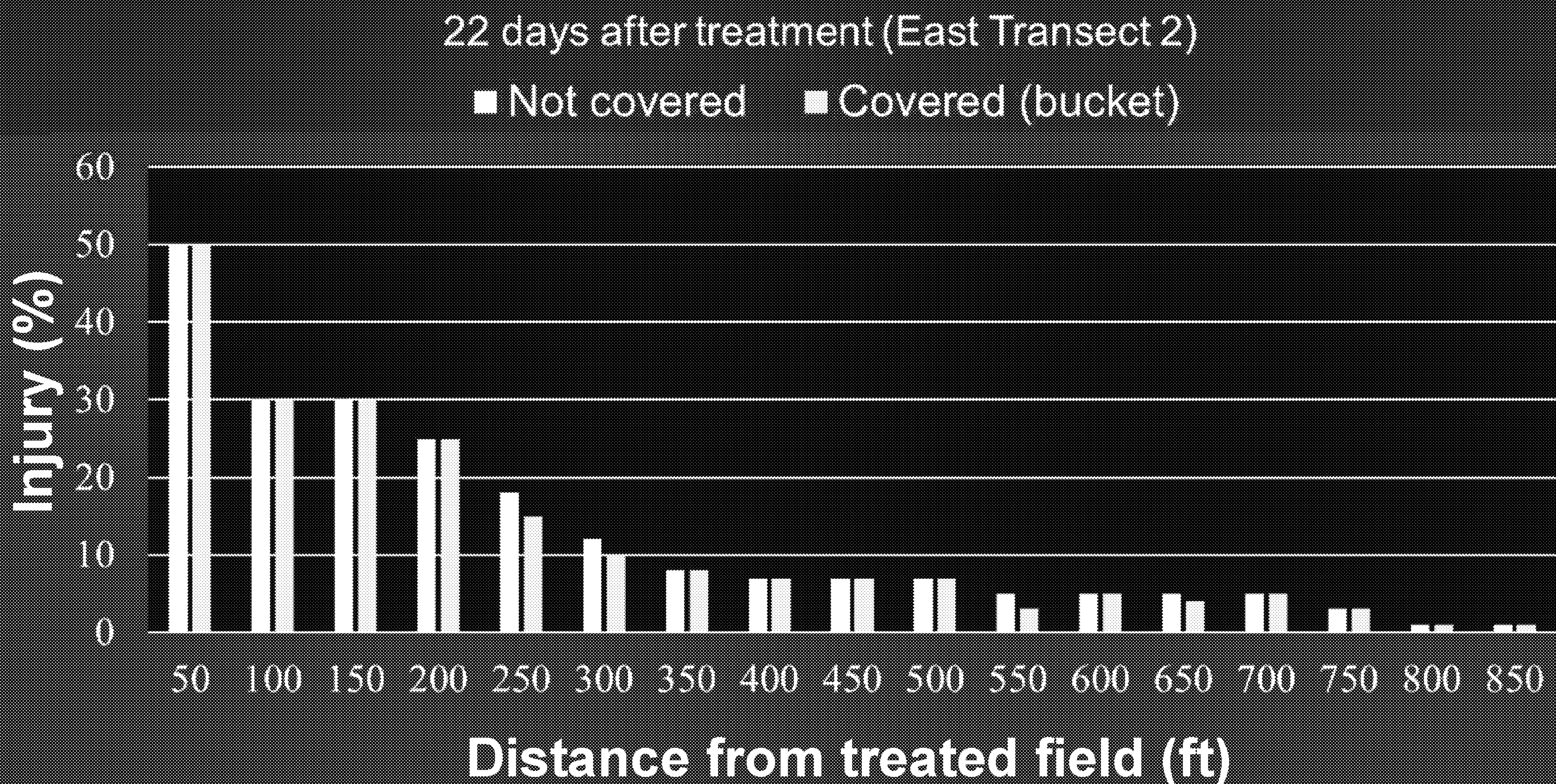
Injury to Soybean Adjacent to and Beneath Tarps

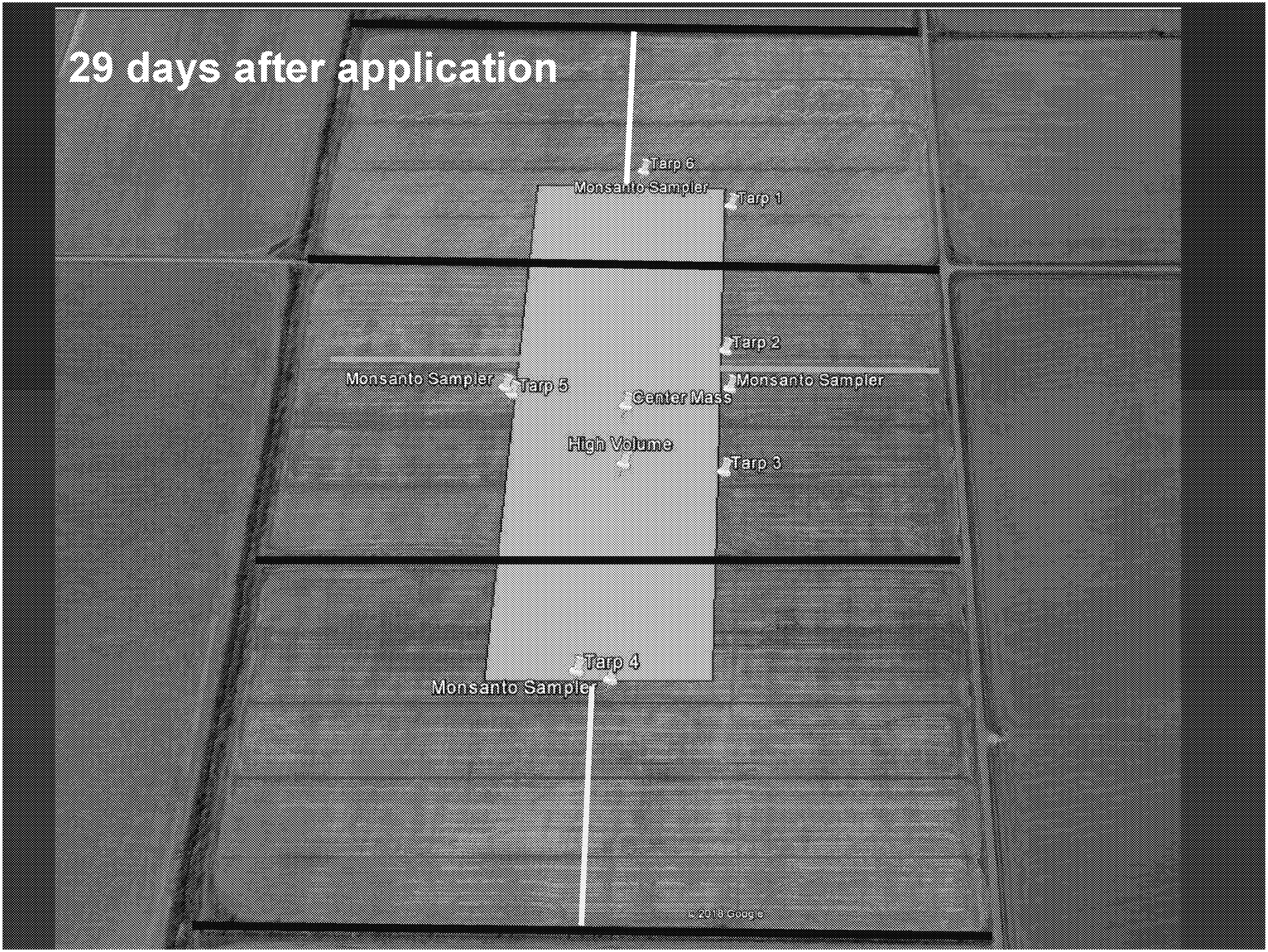



17 days after application
Roundup Ready
Xtend

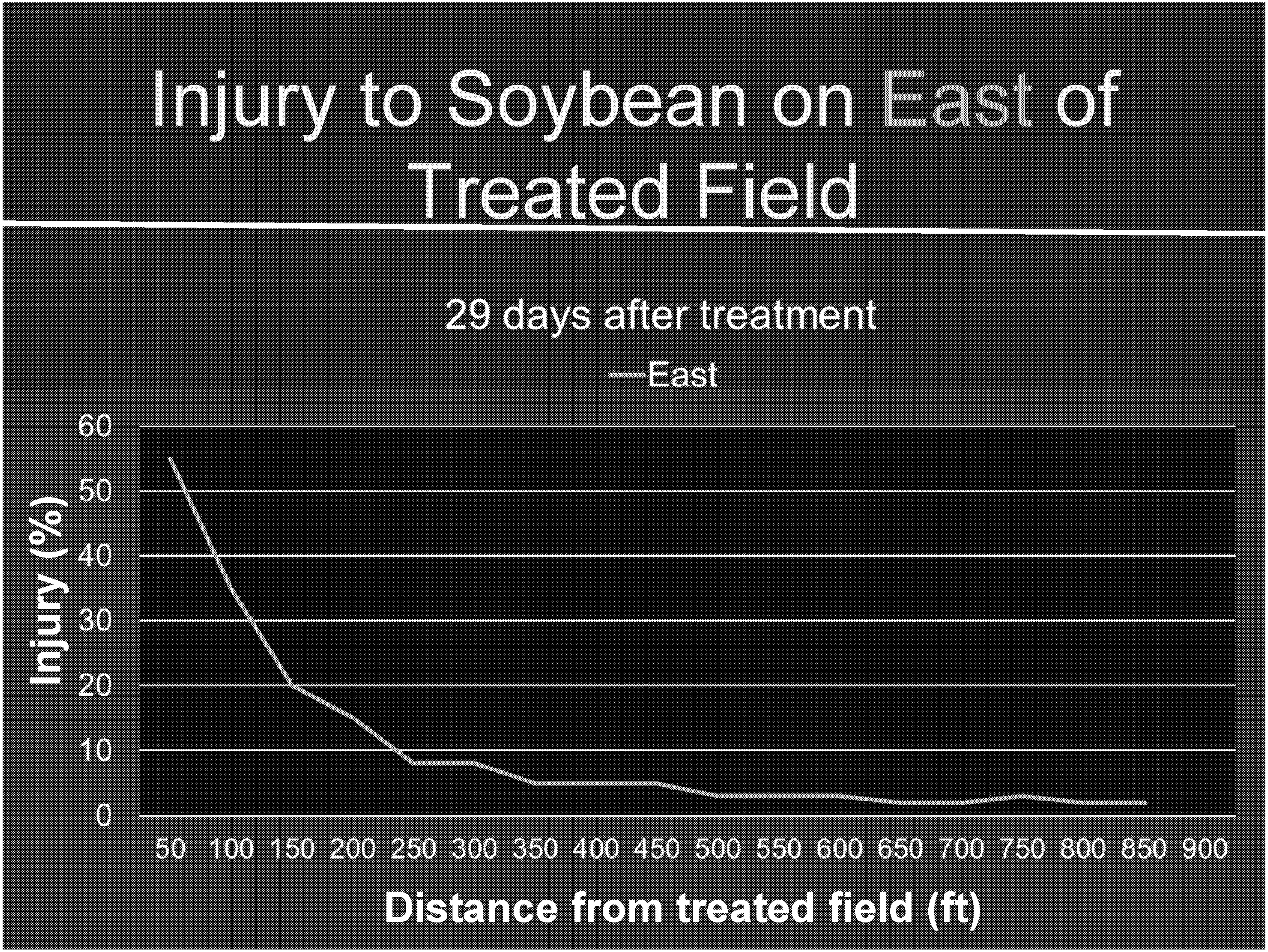

15 and 22 days
after application
Tarp 6
Monsanto Sampler
Tarp 1
Tarp 2
Monsanto Sampler
Tarp 5
Monsanto Sampler
Center Mass
High Volume
Tarp 3
Tarp 4
Monsanto Sampler
© 2018 Google

Contribution of Secondary Movement to Overall Soybean Injury

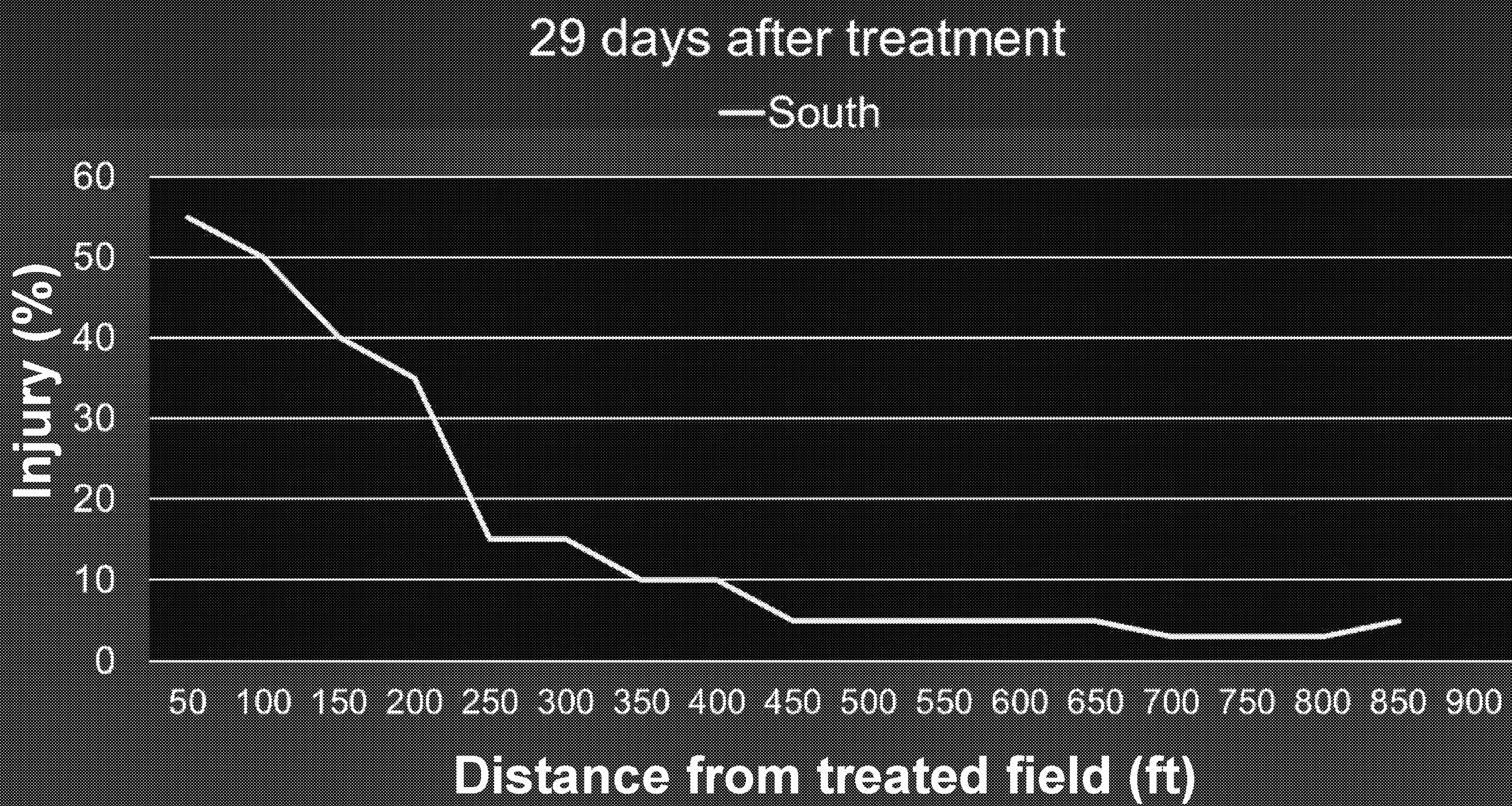




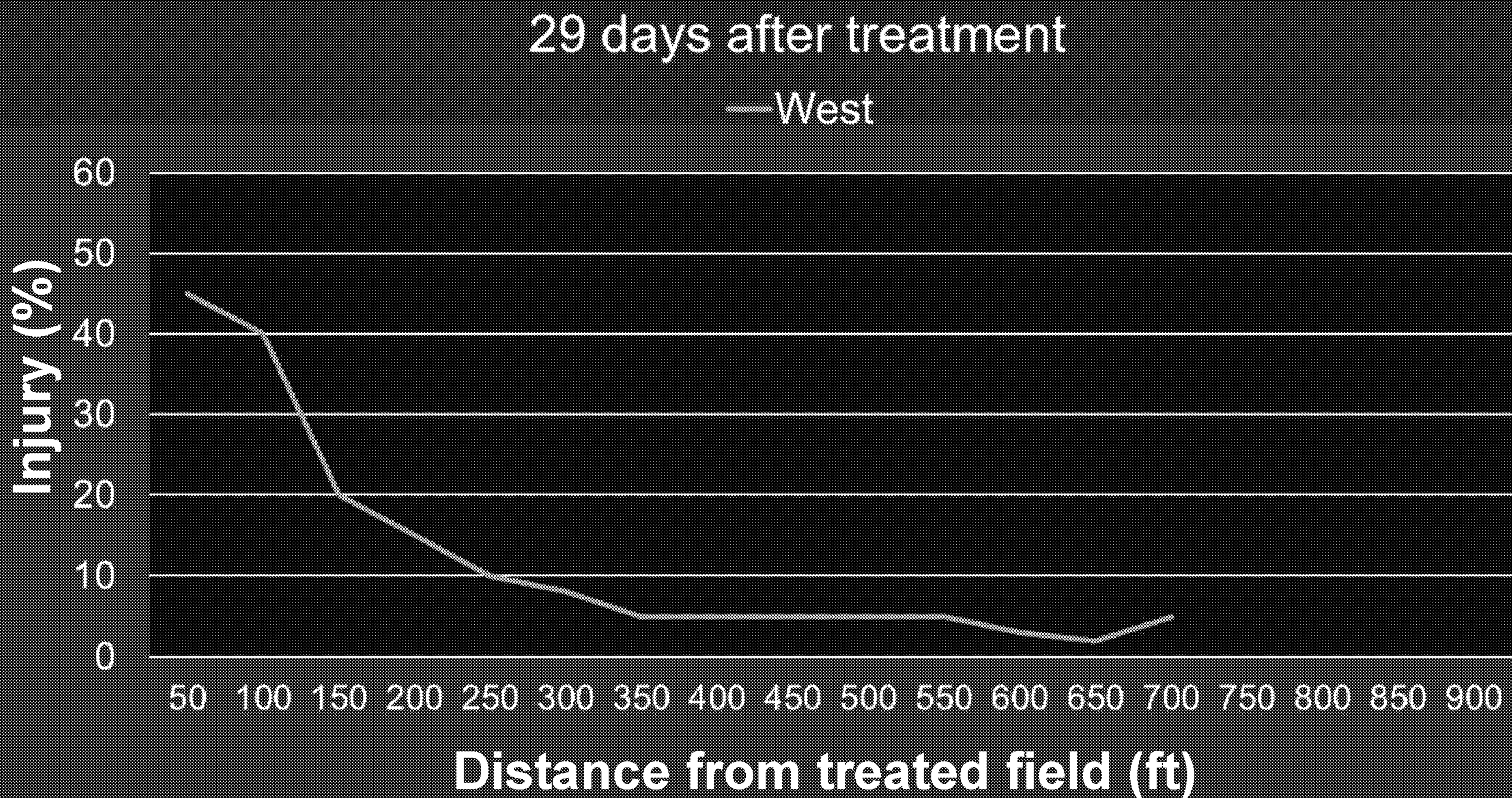
29 days after application
Tarp 6
Monsanto Sampler
Tarp 1
Tarp 2
Monsanto Sampler
Tarp 5
Monsanto Sampler
Center Mass
High Volume
Tarp 3
Tarp 4
Monsanto Sampler
© 2018 Google


Injury to Soybean on East of Treated Field
29 days after treatment
East
Injury (%)
60
50
40
30
20
10
0
50 100 150 200 250 300 350 400 450 500 550 600 650 700 750 800 850 900
Distance from treated field (ft)

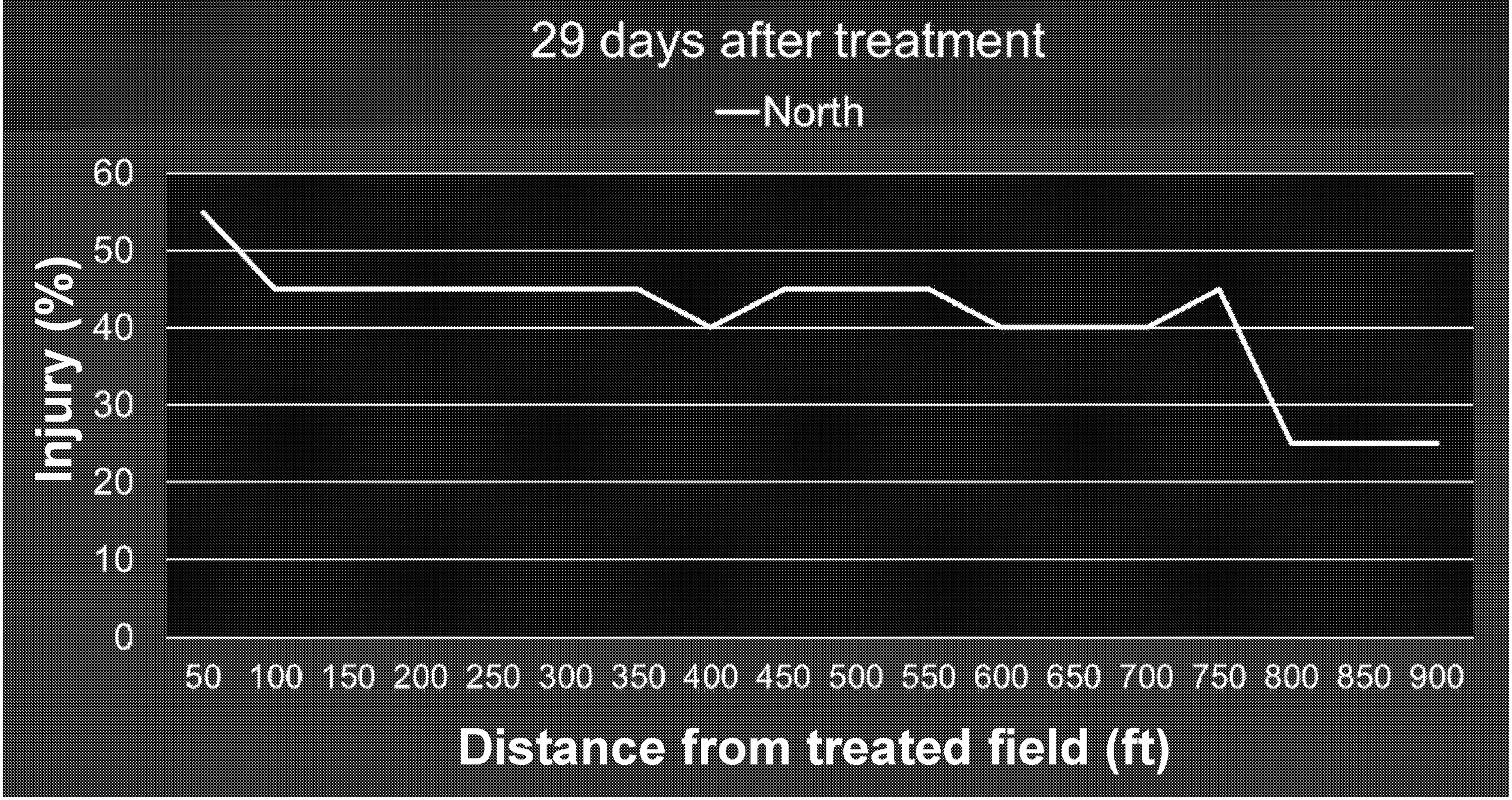
Injury to Soybean on South Side of Treated Field



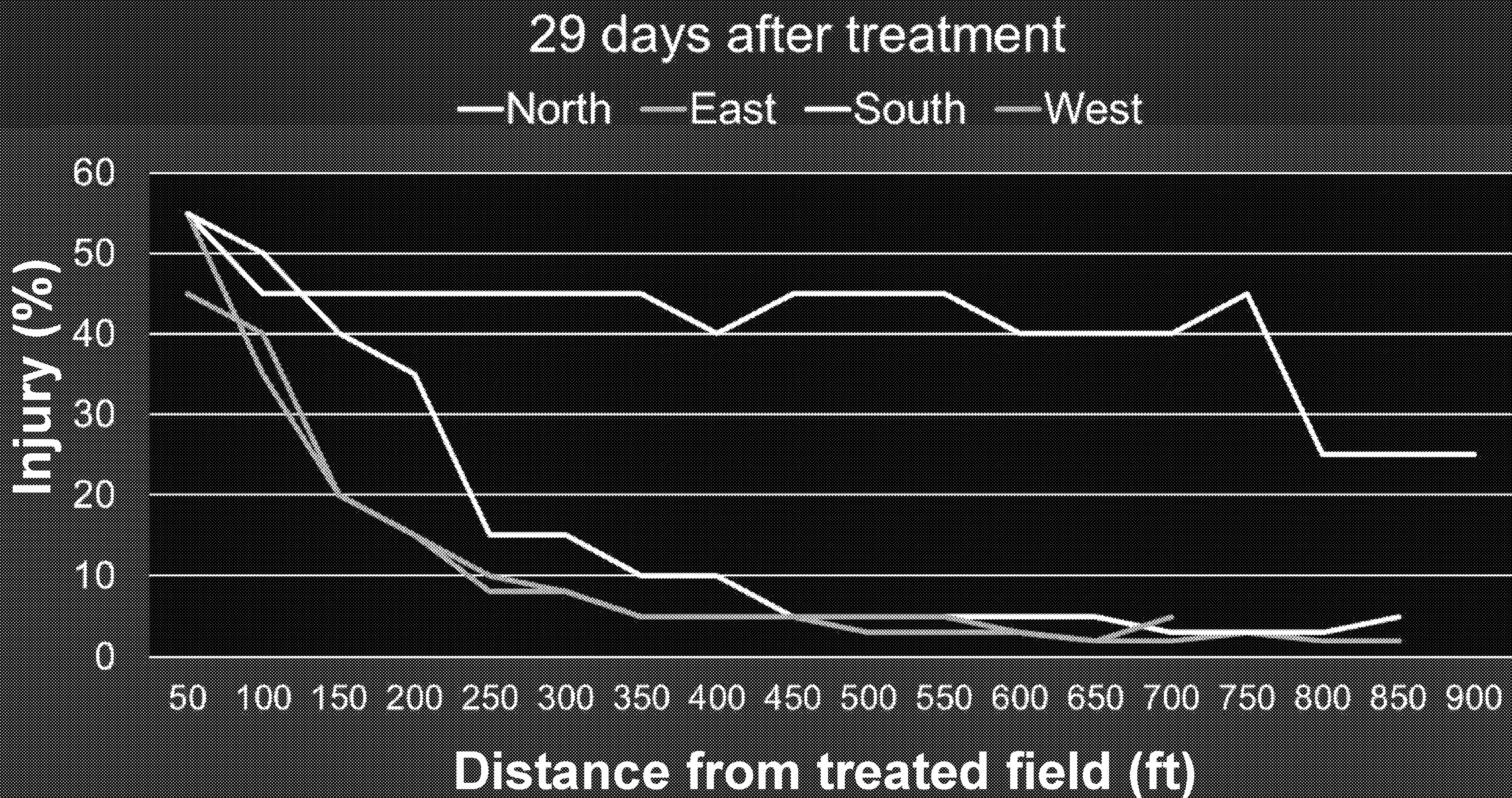
Injury to Soybean on West Side of Treated Field



Injury to Soybean on North Side of Treated Field



Injury to Soybean on Each Side of Treated Field



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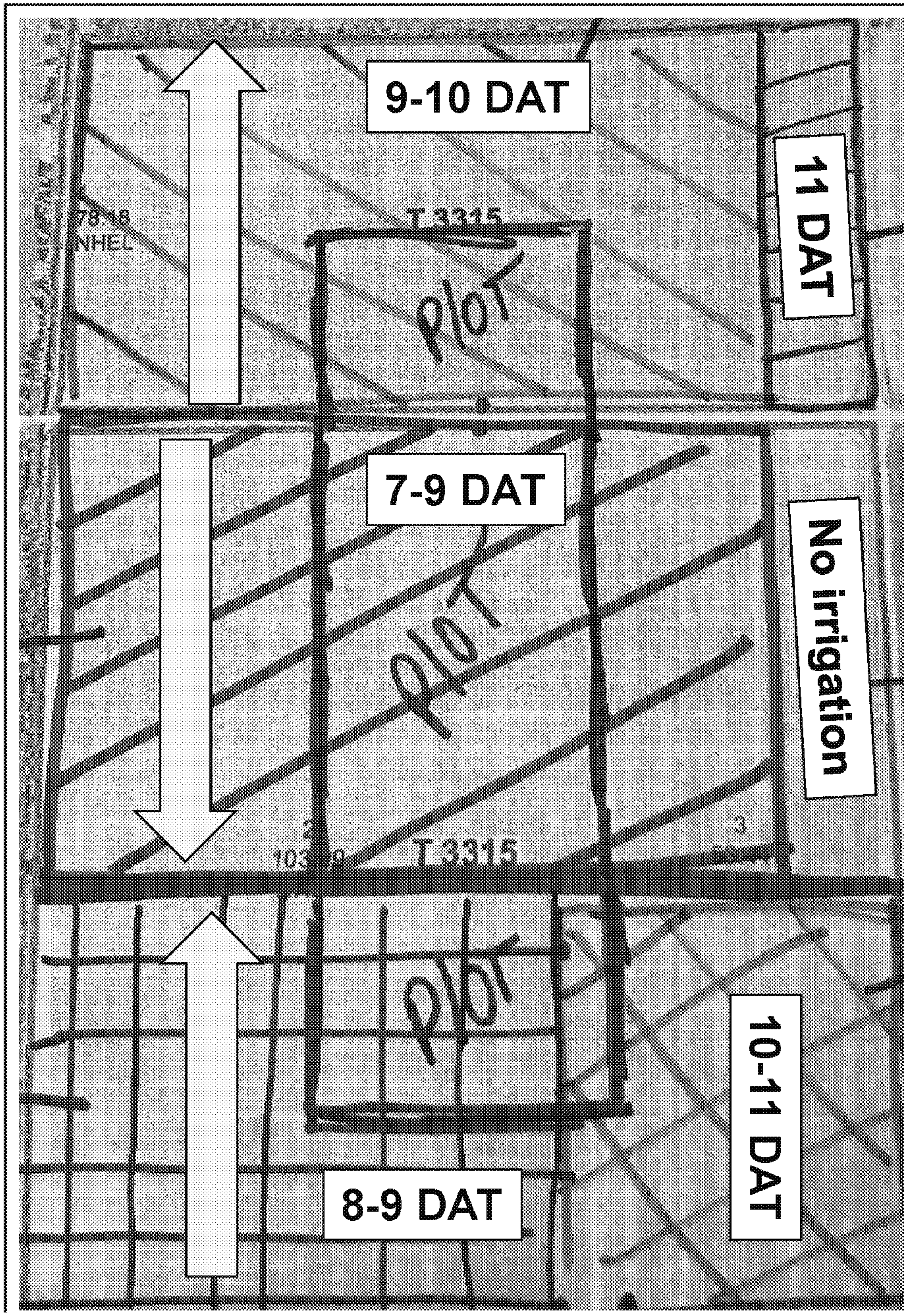
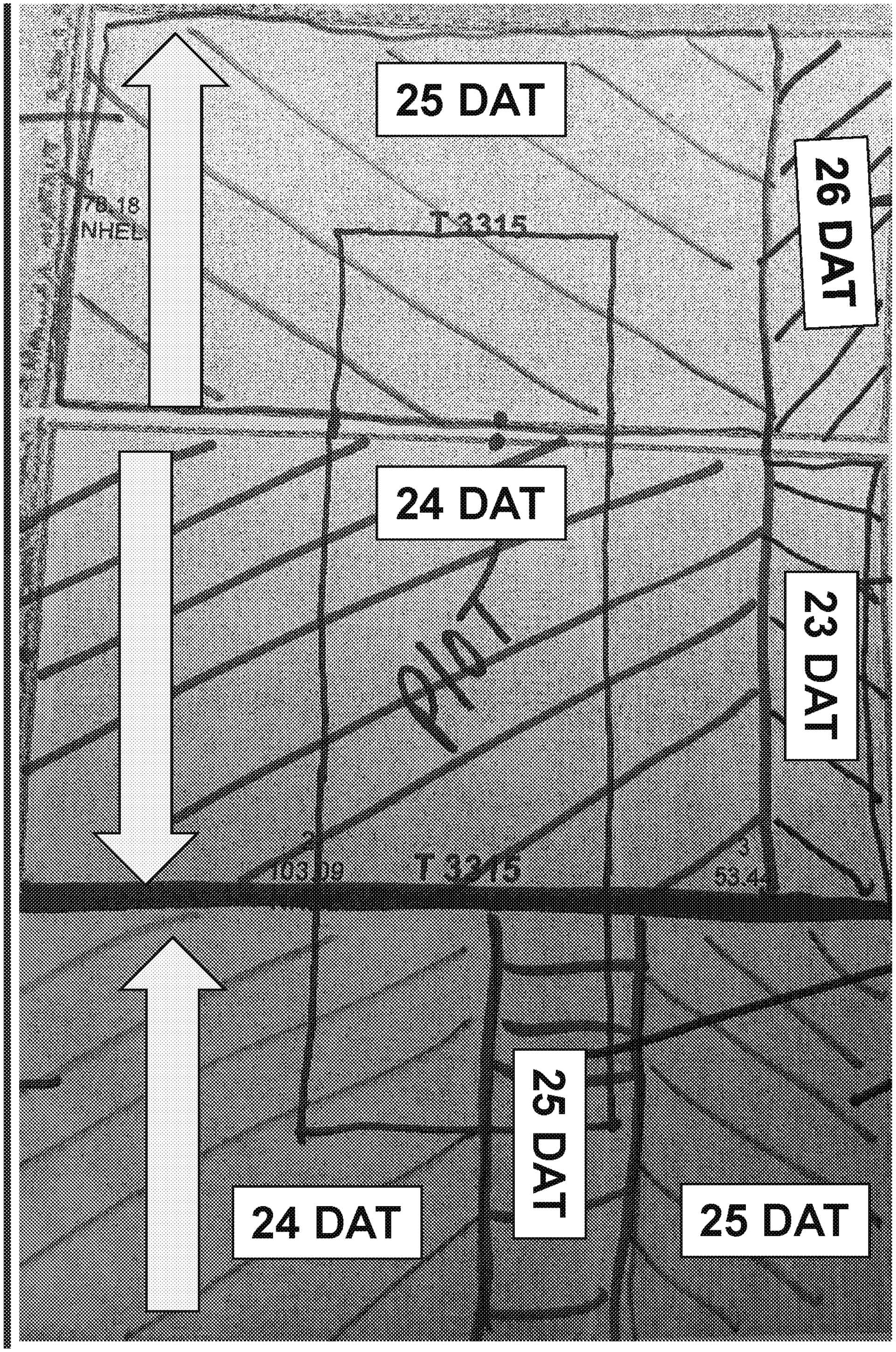


Irrigation Schedule

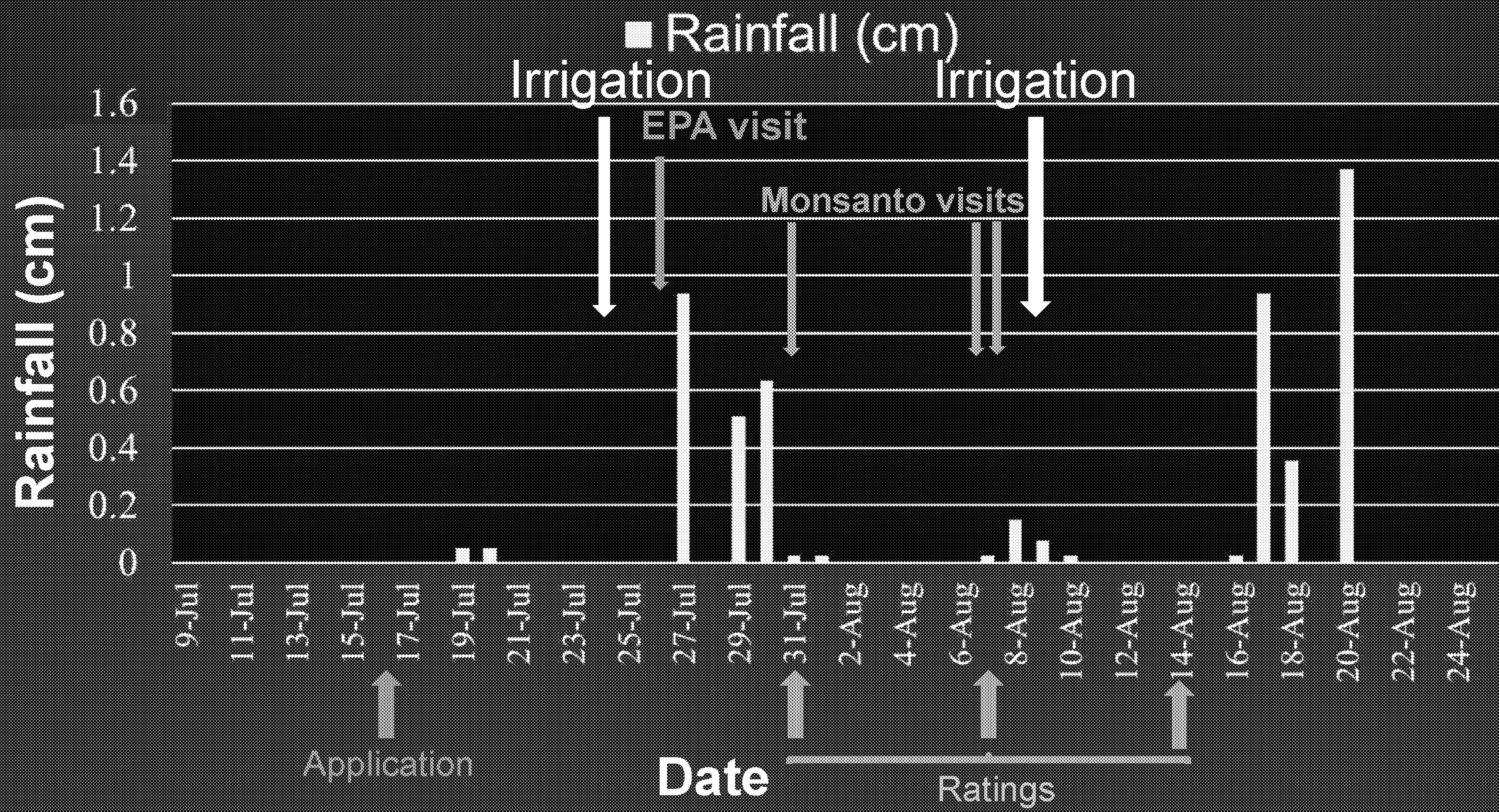
Plot sprayed July 16

Irrigation Schedule

Plot sprayed July 16



Rainfall, Irrigation, & Field Visits

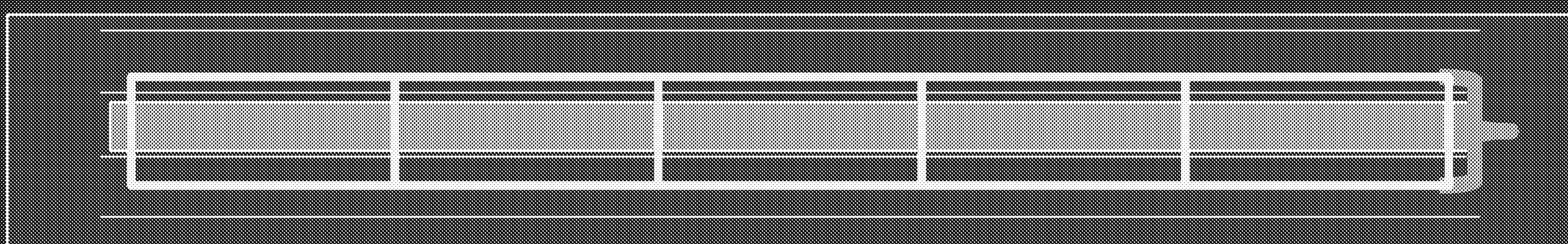


Takeaways from Trial

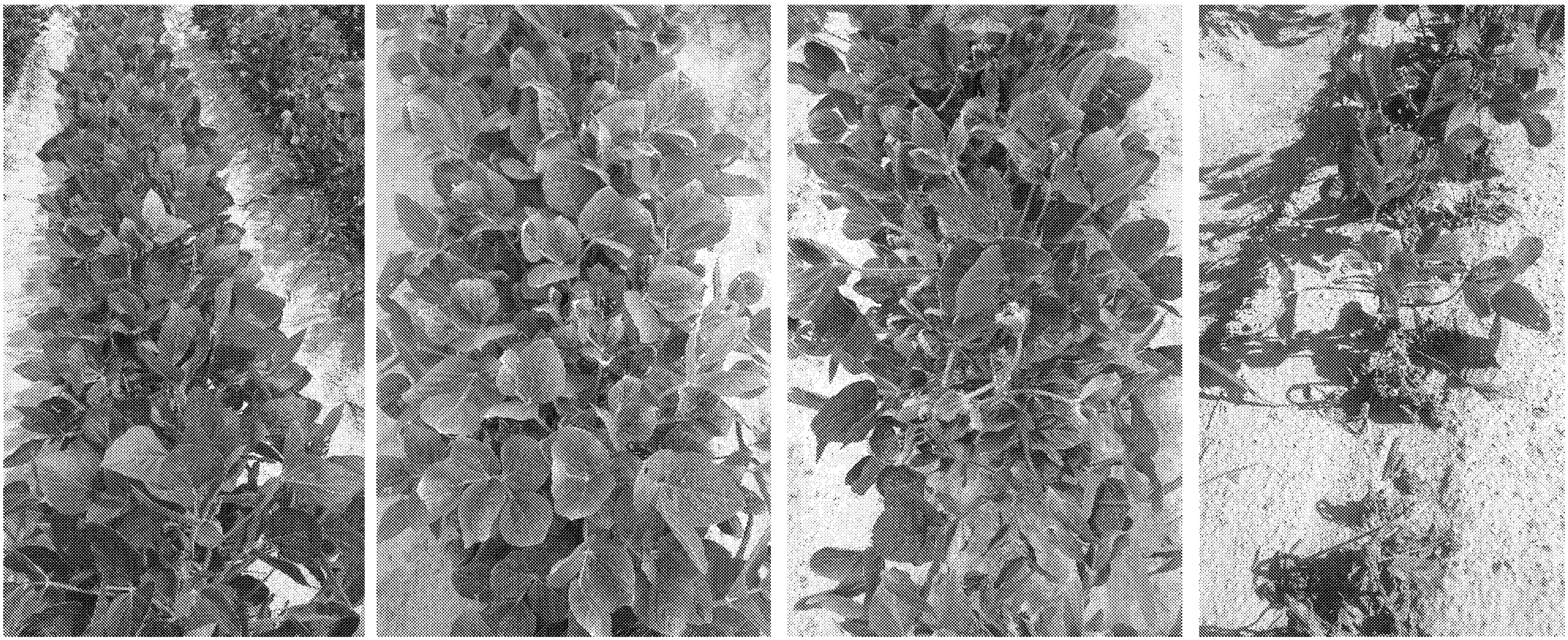
- Symptomology observed on all four sides of field
- Secondary movement contributed greatly to observed damage
  - Volatility
  - Irrigation and possibly rainfall
- Damaged area from dicamba exceeded size of treated area

Irrigation with Contaminated Tailwater

- Dicamba dissolved in irrigation water at five known concentrations
- Applied as 1 acre inch of water via furrow irrigation
  - Held water on field with in-furrow soil dams to facilitate timely application of all treatments
- Ratings collected from zones within a furrow
  - Mid-furrow ratings represent "average" impact
  - Bottom of furrow ratings represent max impact



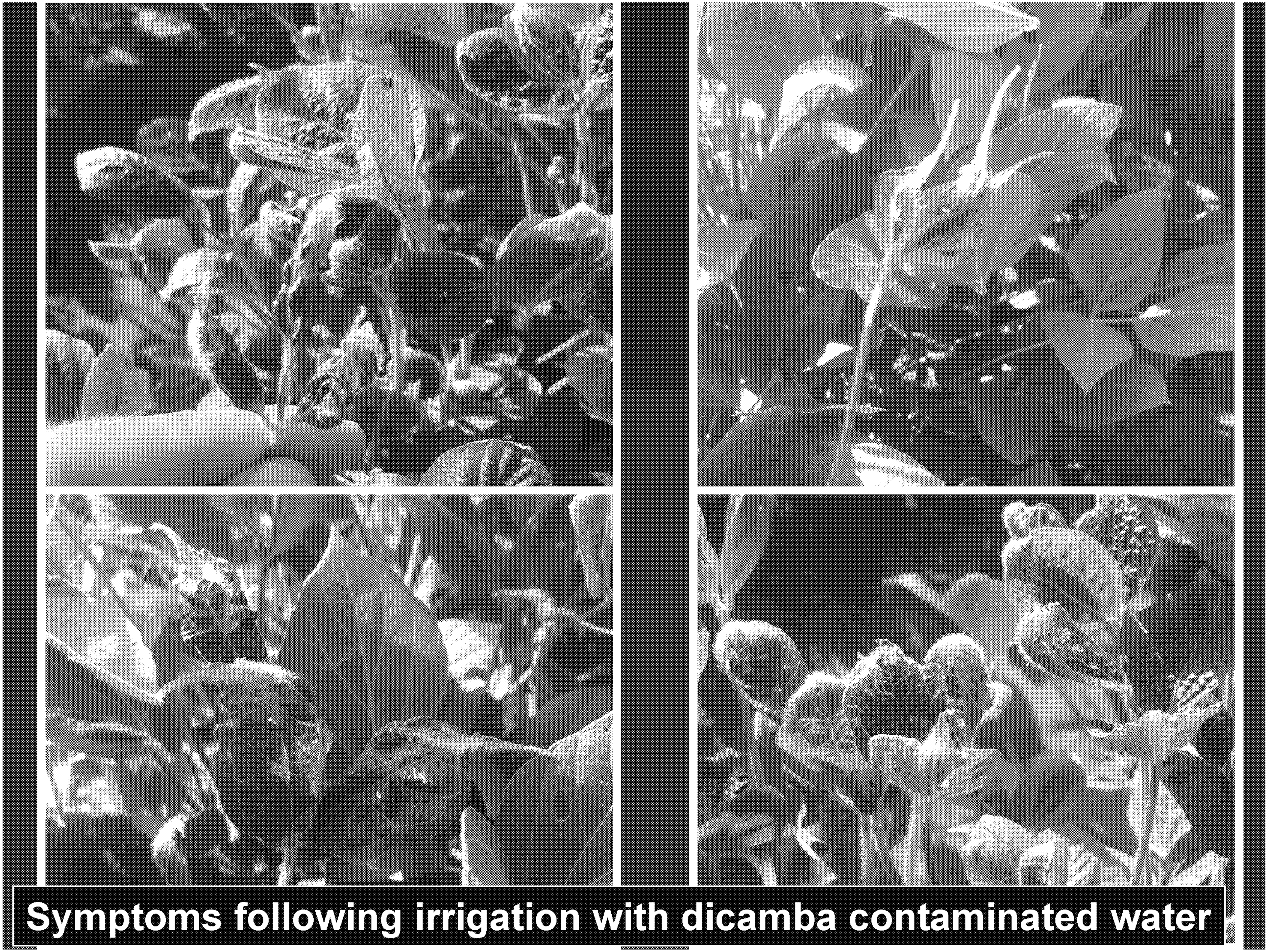
Damage from dicamba in irrigation water applied at V3 stage



None | **0.1 ppm** | **0.5 ppm** | **5 ppm**

Dicamba in irrigation water applied at V3 and R1 growth stages

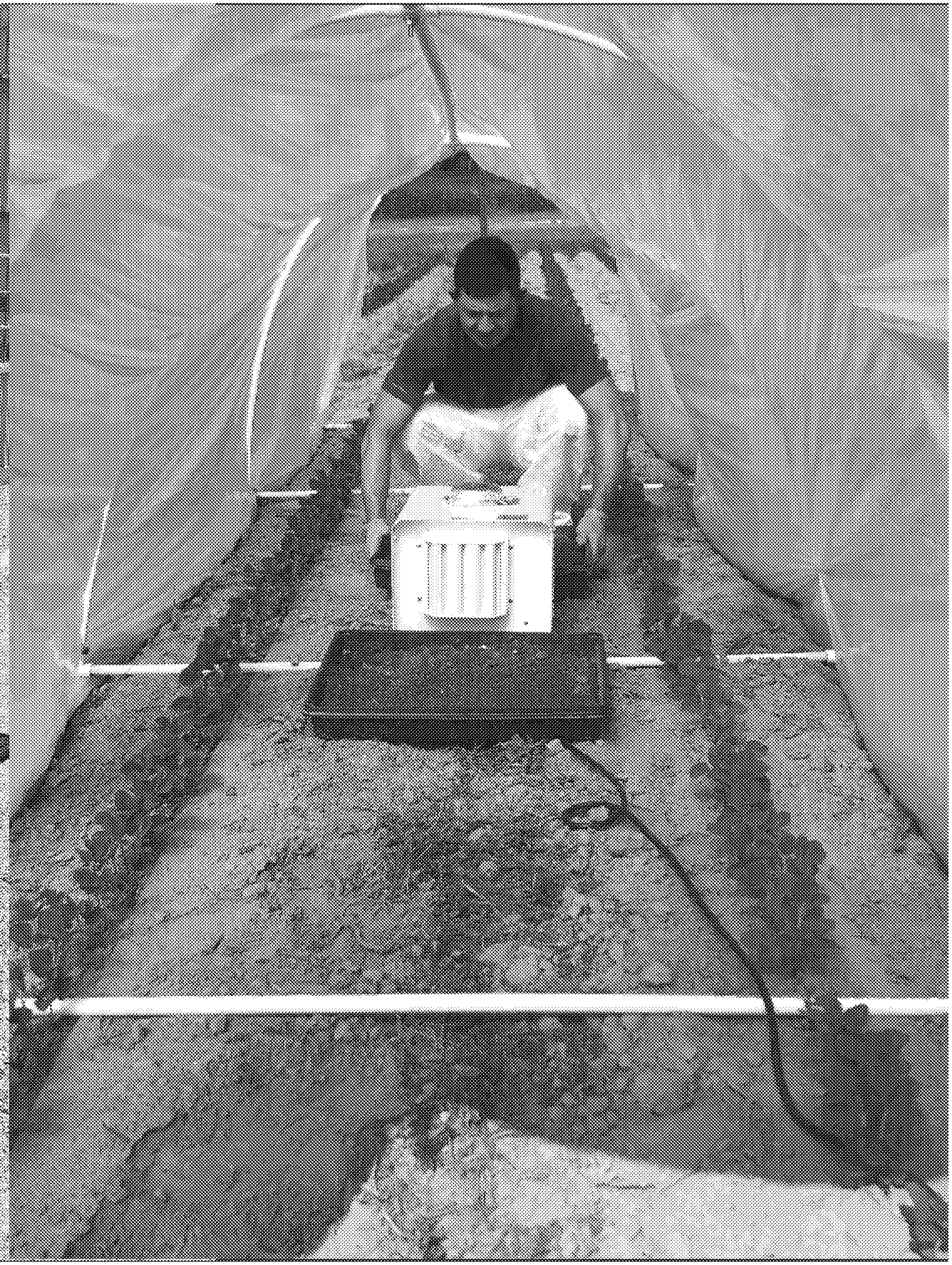
V3 **0.1 ppm** **R1**



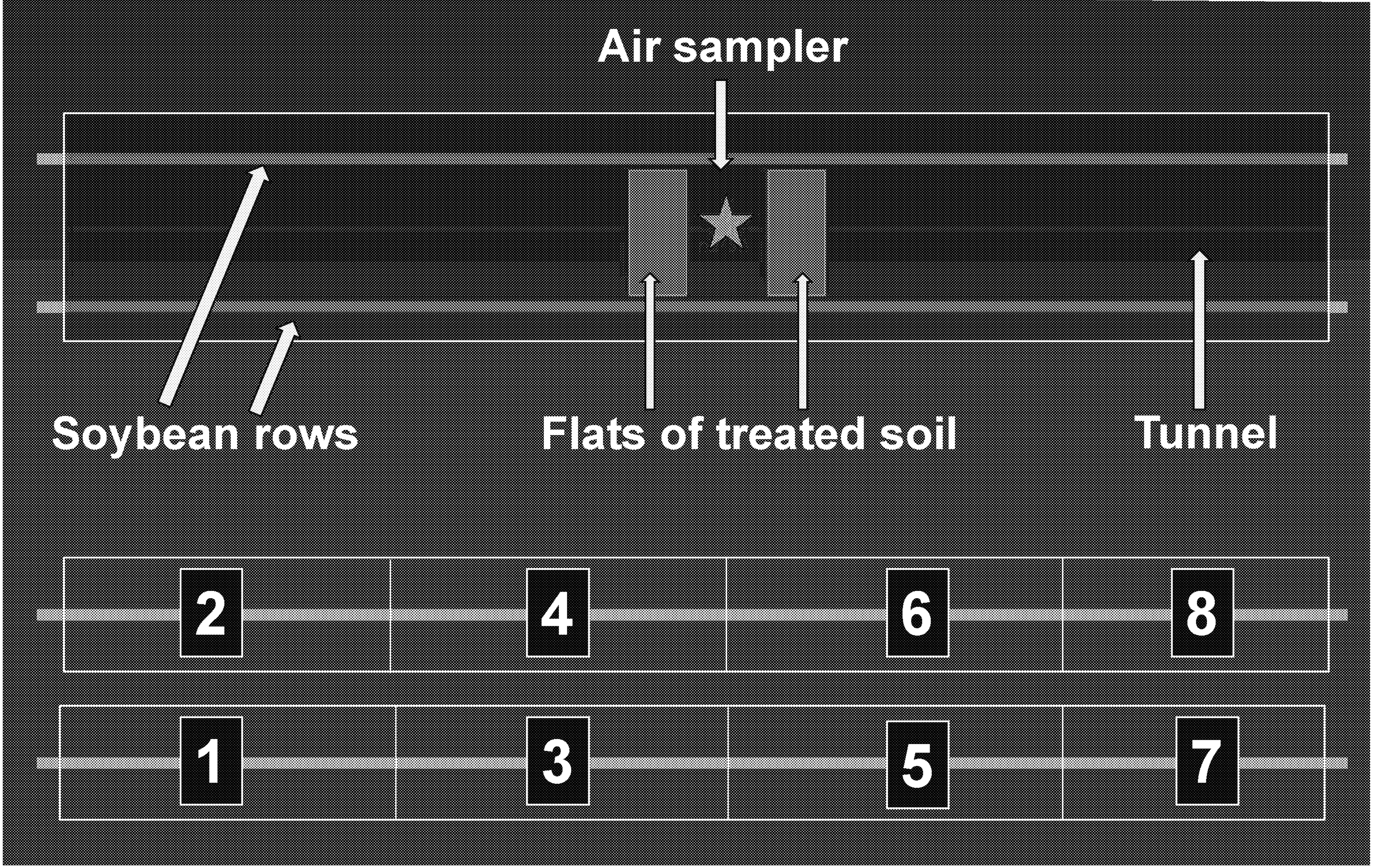
Symptoms following irrigation with dicamba contaminated water


September 18, 2018

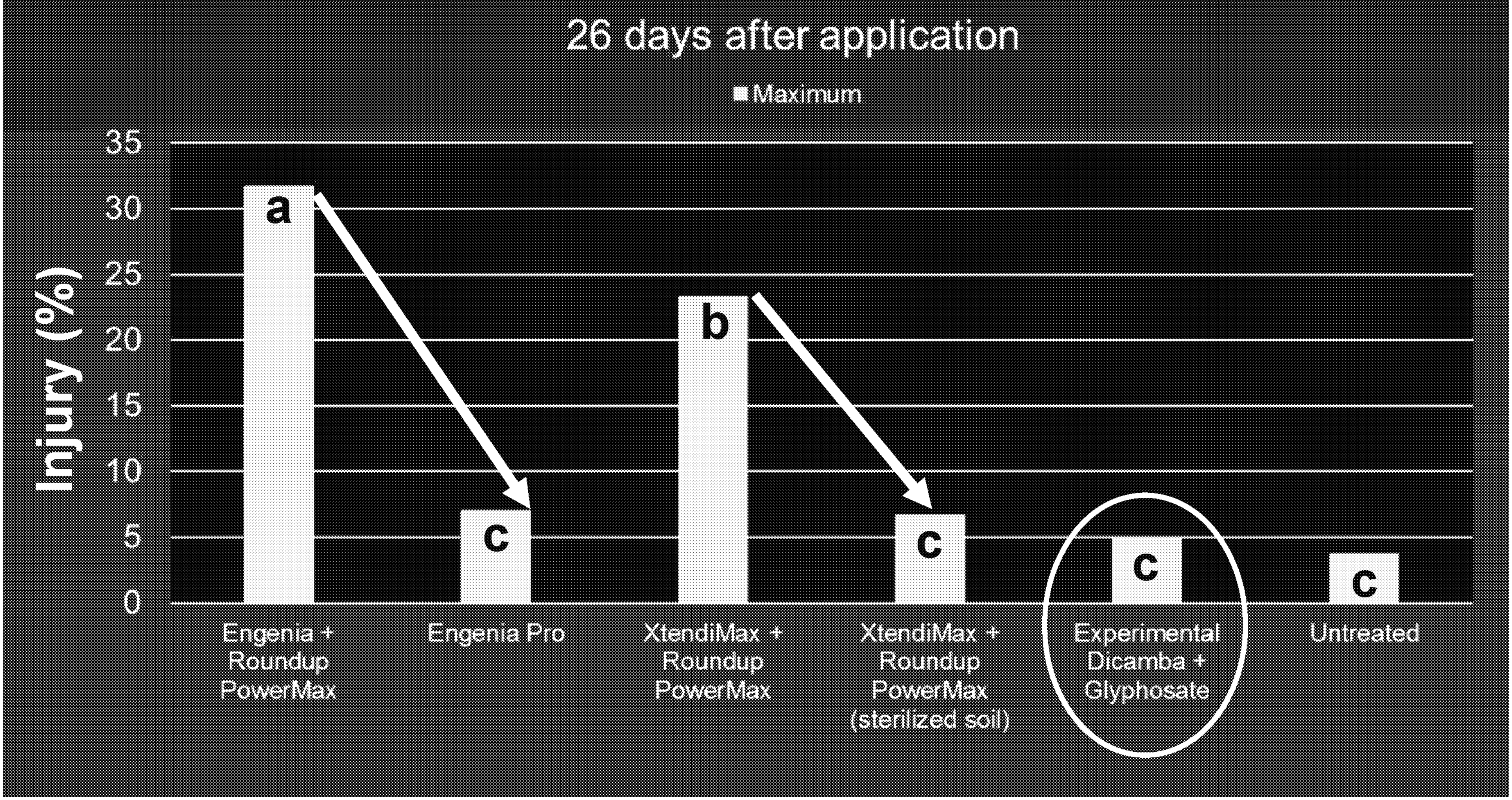
- Objective: Assess relative differences in volatility of auxin products in the field inside of low tunnels
- Location: Fayetteville, Lonoke, & Tillar
- Growth stage: V2 to V6
- Tunnels and treated soil removed 48 hours after application

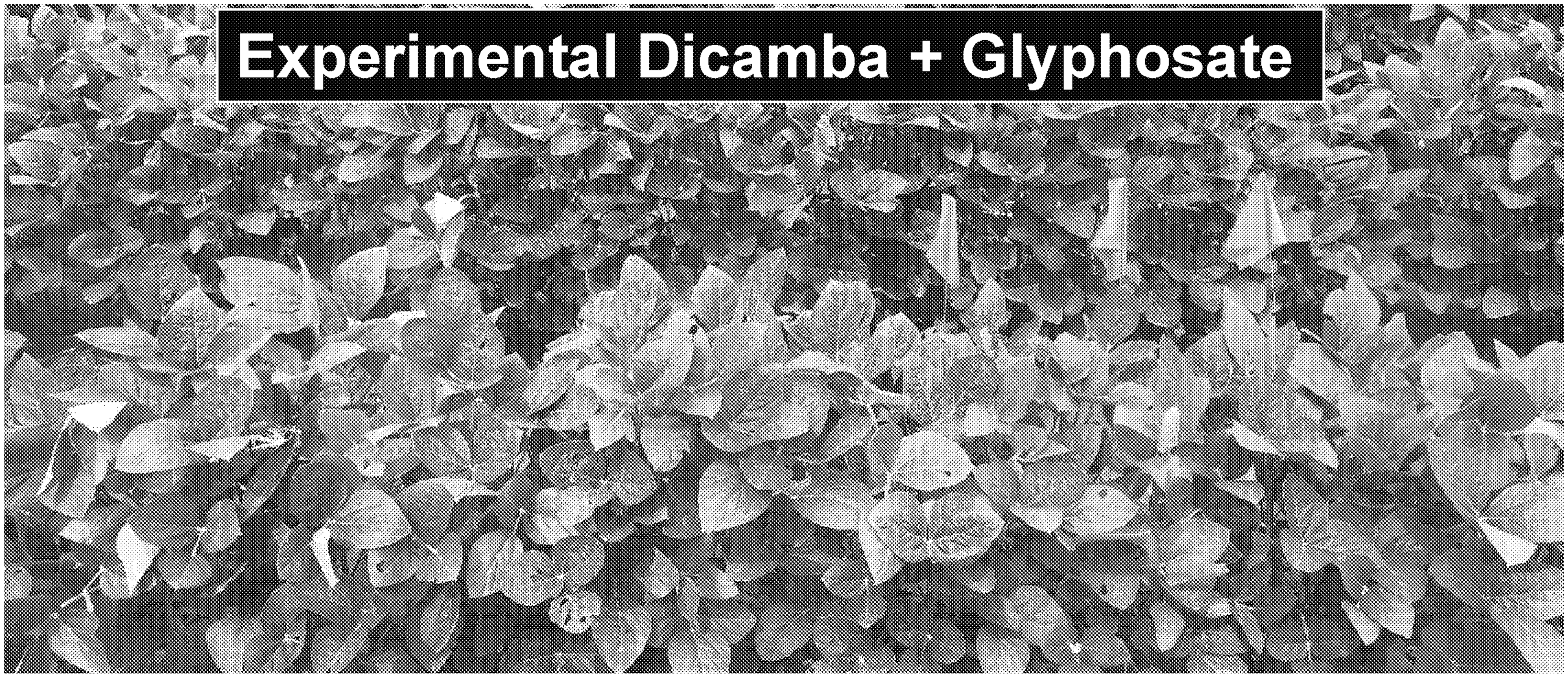


Low Tunnel Volatility Setup



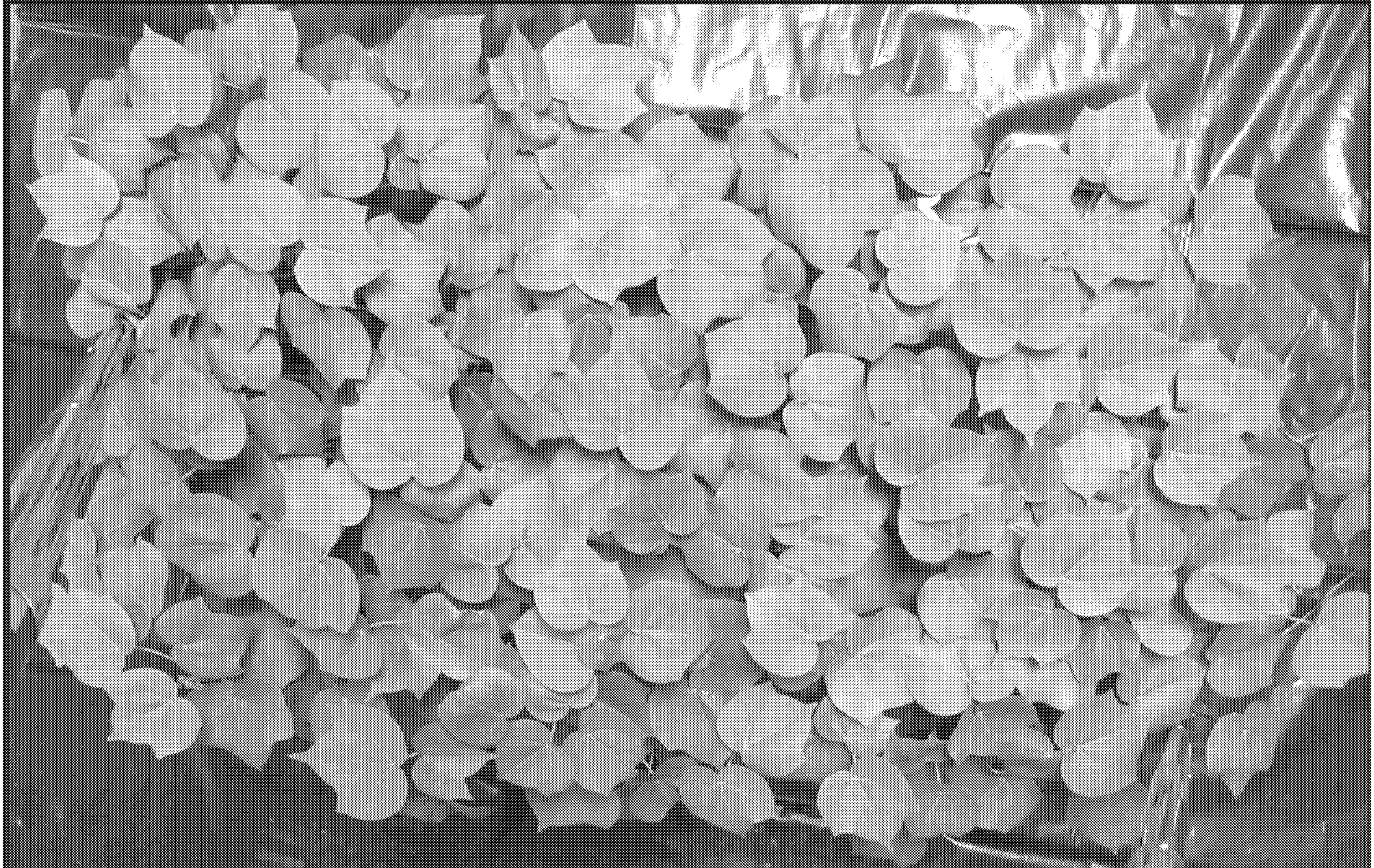
Low Tunnel Volatility Evaluation of Dicamba Formulations



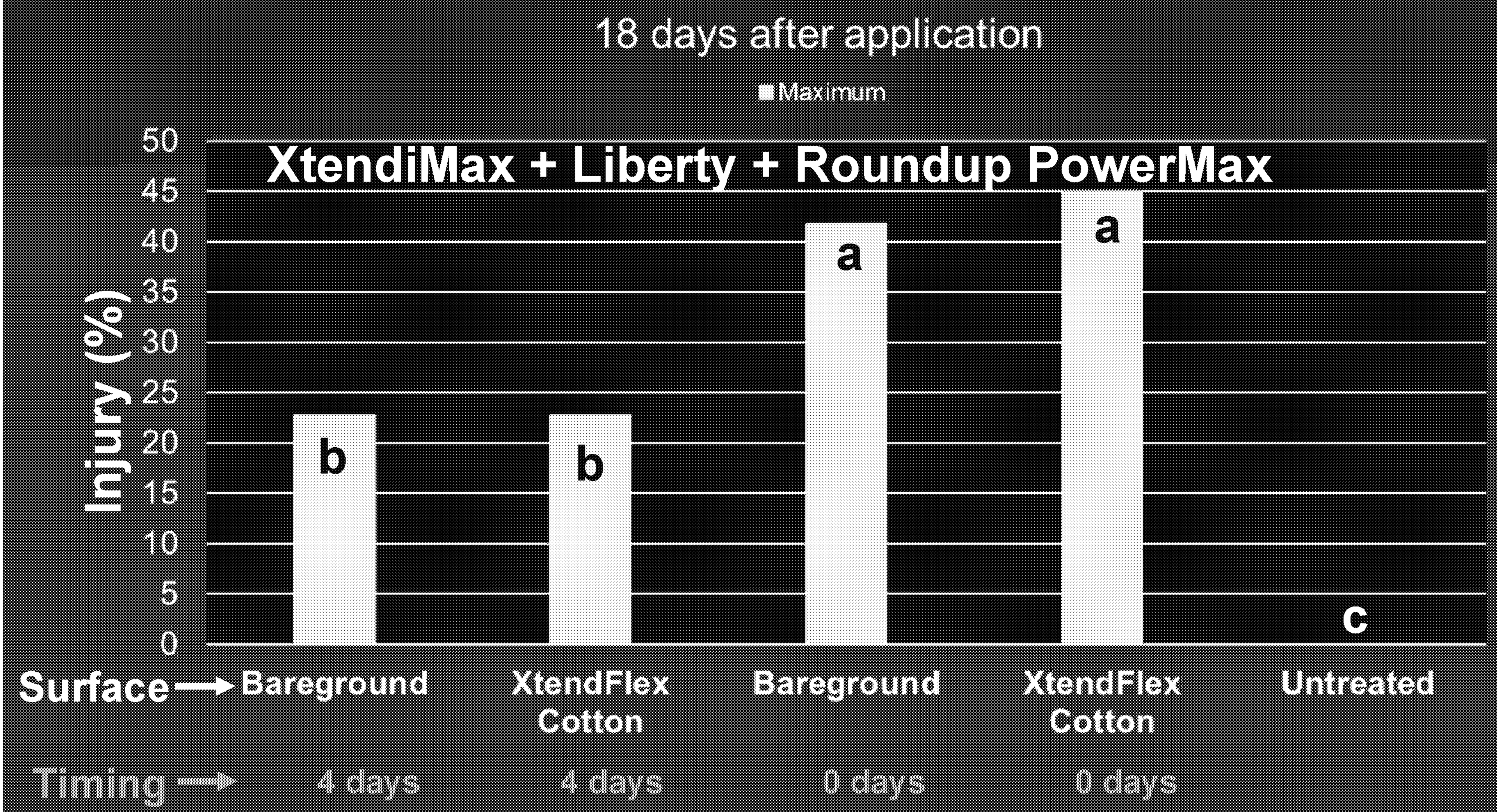

Experimental Dicamba + Glyphosate


Engenia + Roundup PowerMax

Xtend Cotton

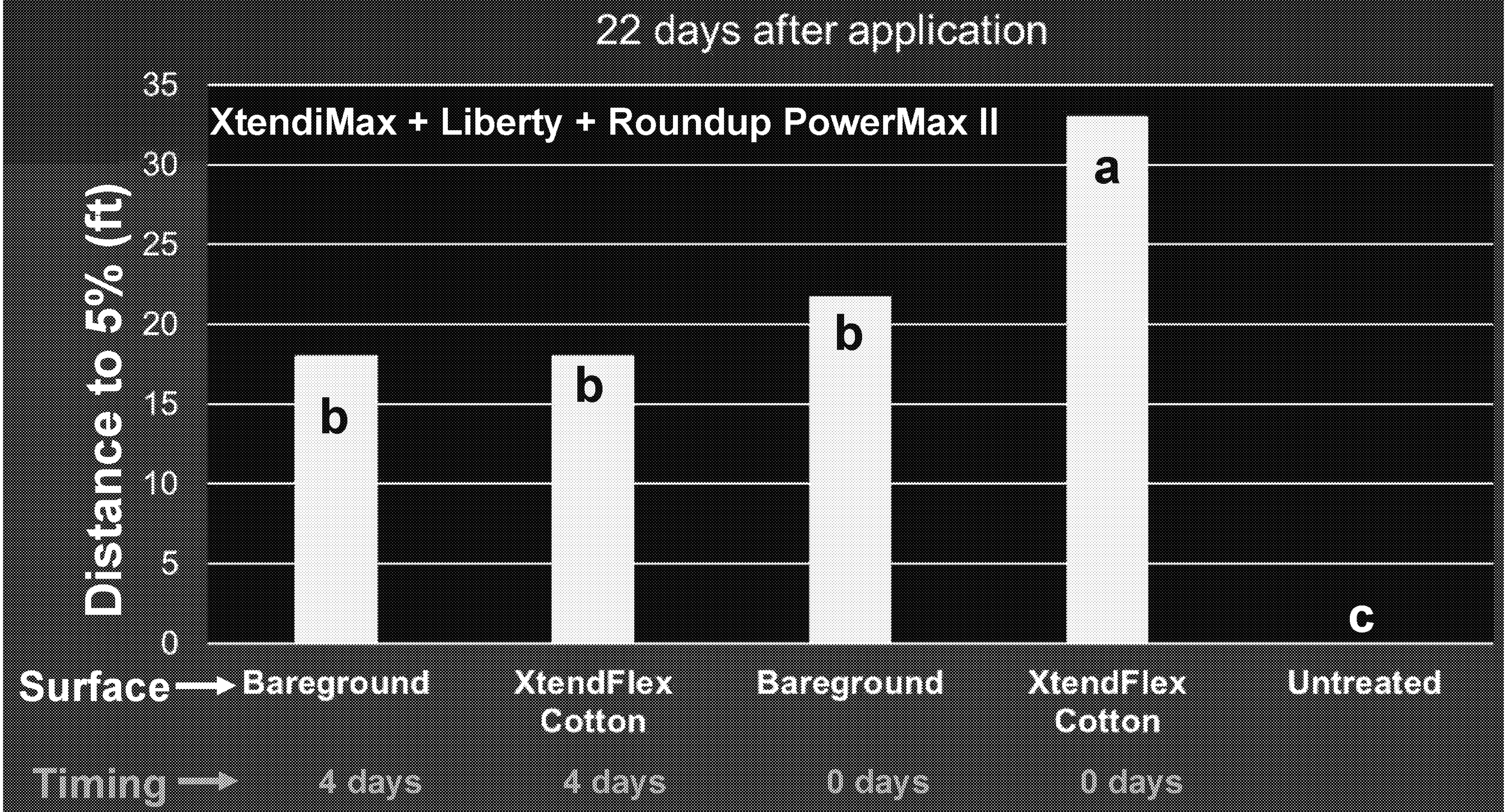


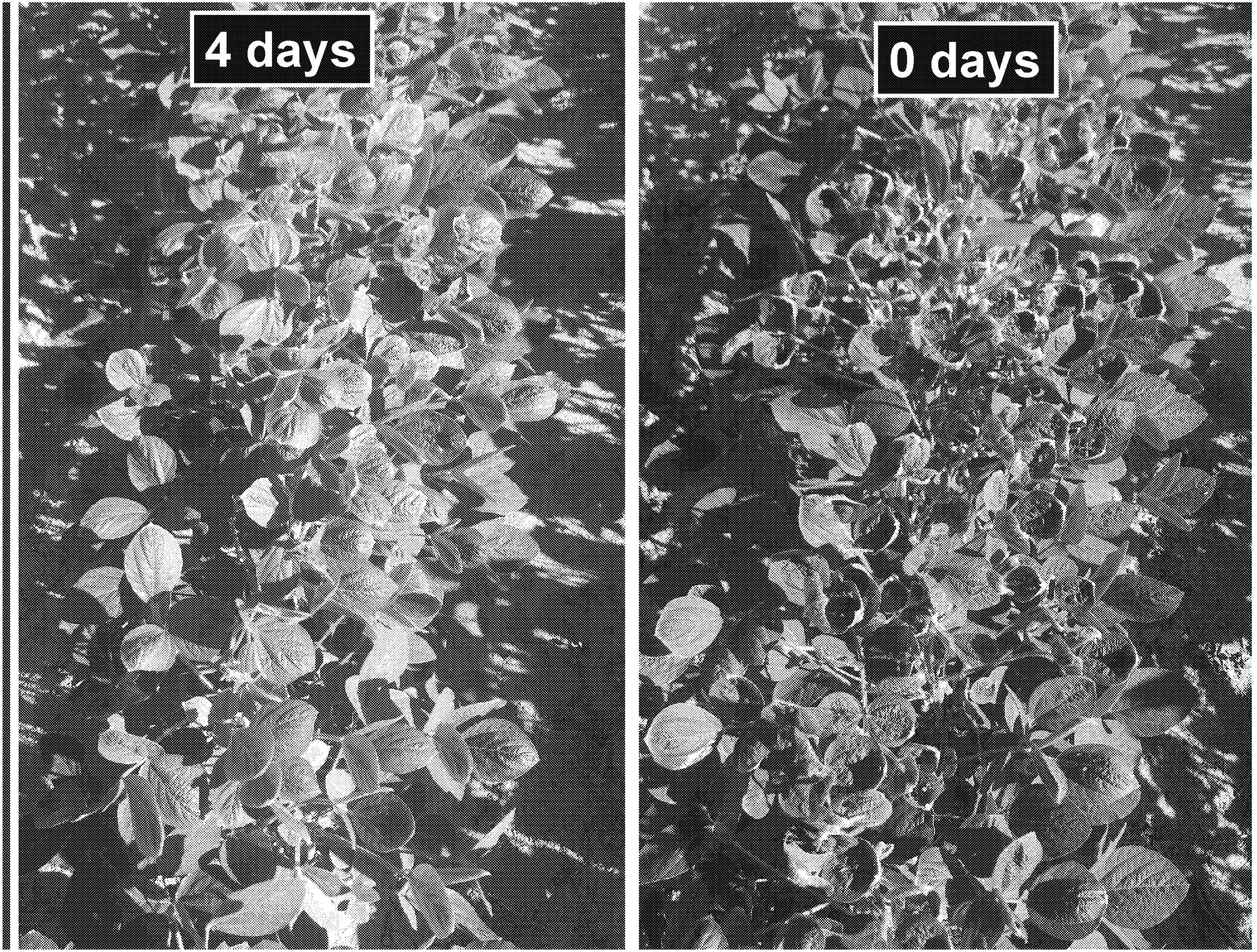
Low Tunnel Volatility Evaluation (Surface and Timing)

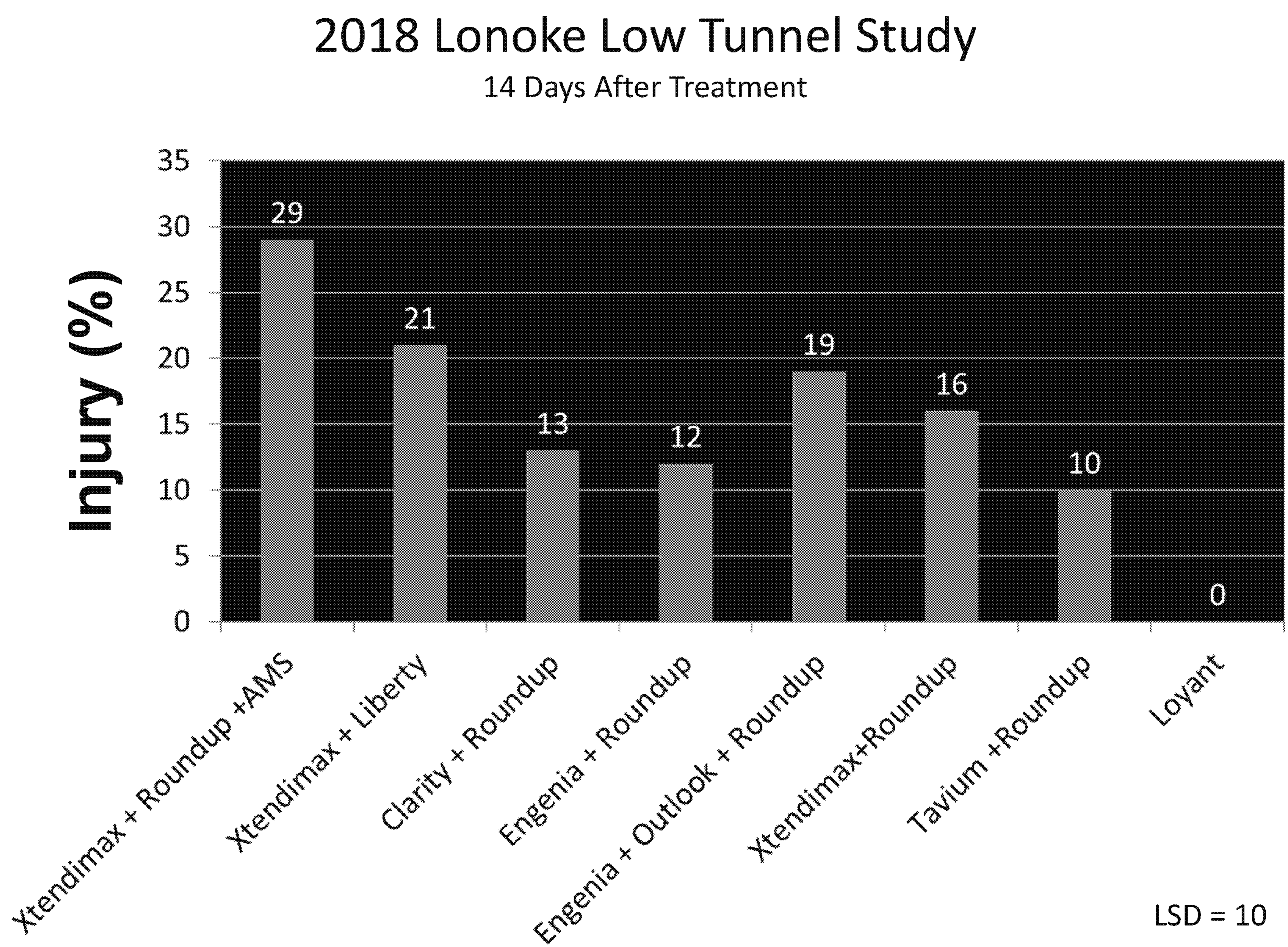


ED_002296_00002543-00063

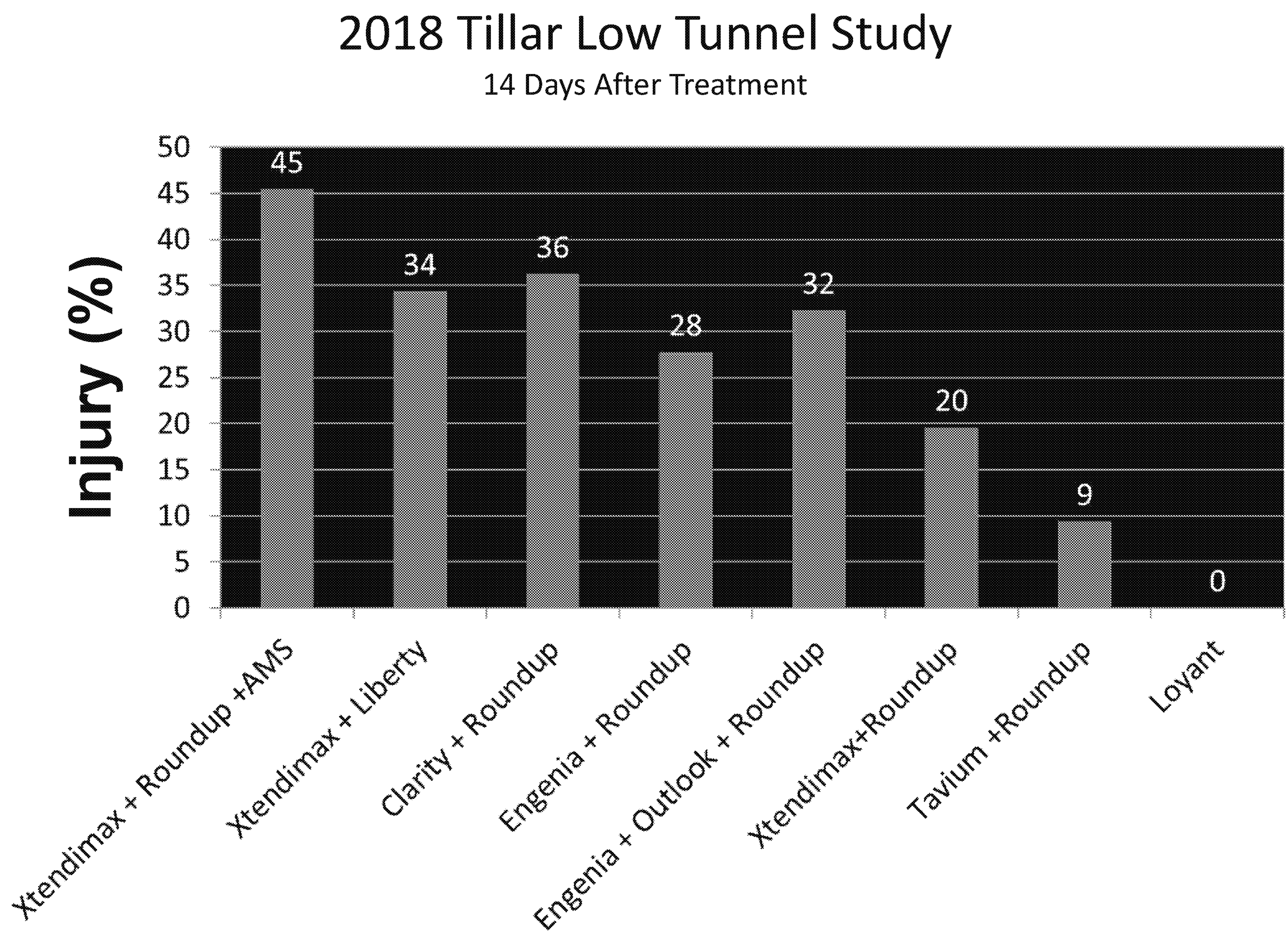
Low Tunnel Volatility Evaluation (Surface and Timing)

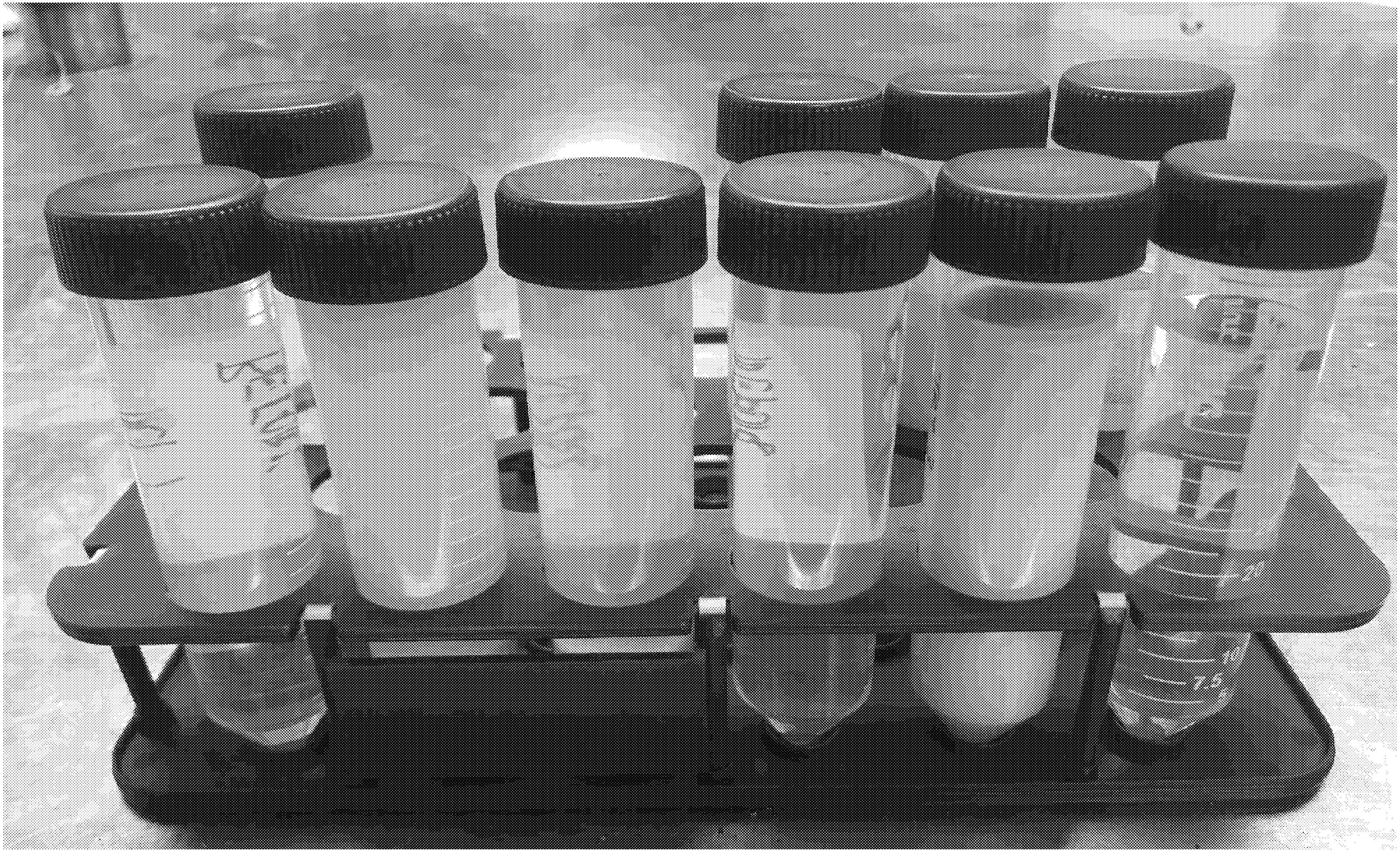



4 days
0 days



2018 Lonoke Low Tunnel Study
14 Days After Treatment
Injury (%)
35
30
25
20
15
10
5
0
29
21
13
12
19
16
10
0
Xtendimax + Roundup +AMS
Xtendimax + Liberty
Clarity + Roundup
Engenia + Roundup
Engenia + Outlook + Roundup
Xtendimax+Roundup
Tavium +Roundup
Loyant
LSD = 10


2018 Tillar Low Tunnel Study
14 Days After Treatment
Injury (%)
50
45
40
35
30
25
20
15
10
5
0
45
34
36
28
32
20
9
0
Xtendimax + Roundup +AMS
Xtendimax + Liberty
Clarity + Roundup
Engenia + Roundup
Engenia + Outlook + Roundup
Xtendimax+Roundup
Tavium +Roundup
Loyant



XtendiMax

XtendiMax + SelectMax

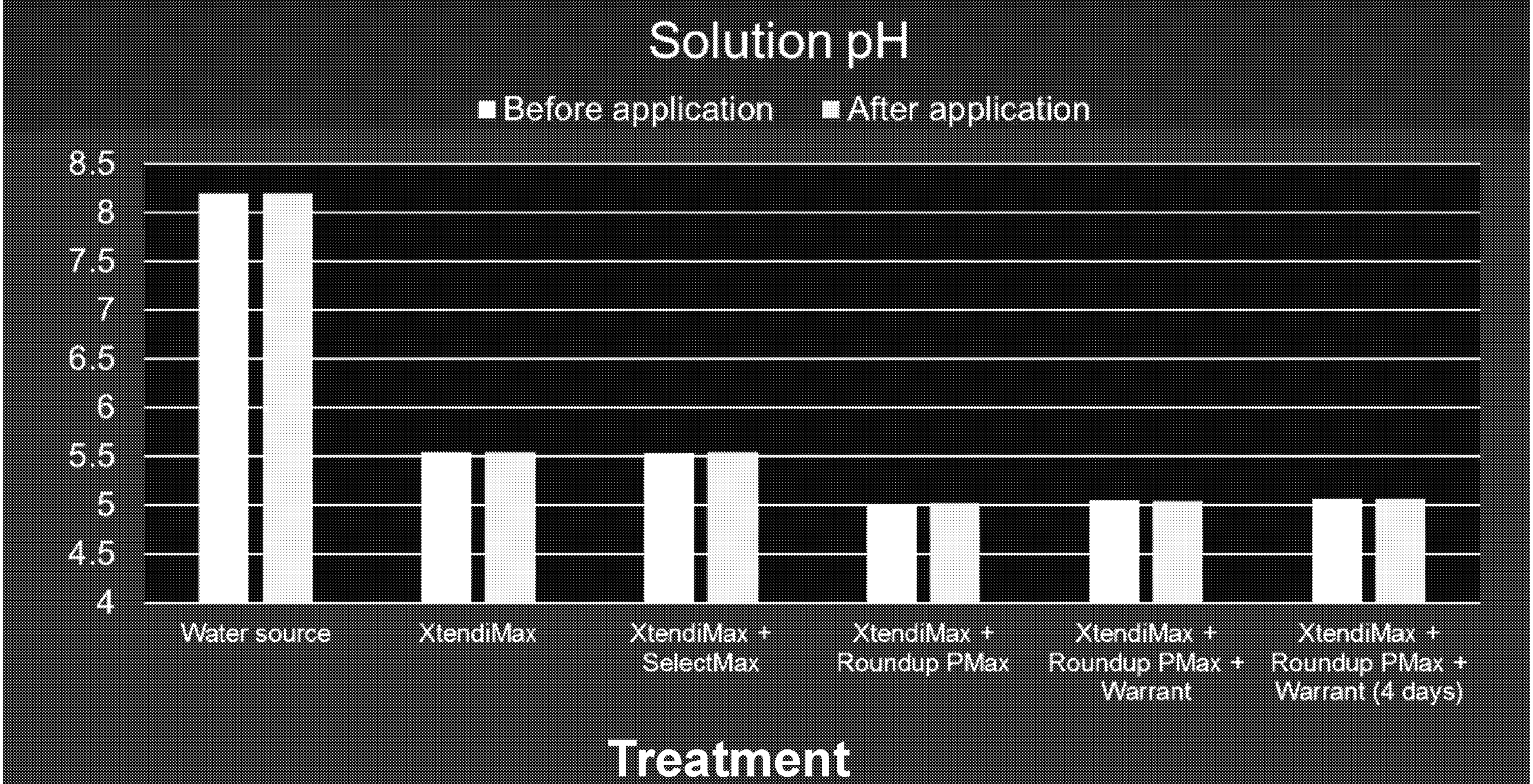
XtendiMax + Rdp PMax

XtendiMax + Rdp Pmax + Warrant

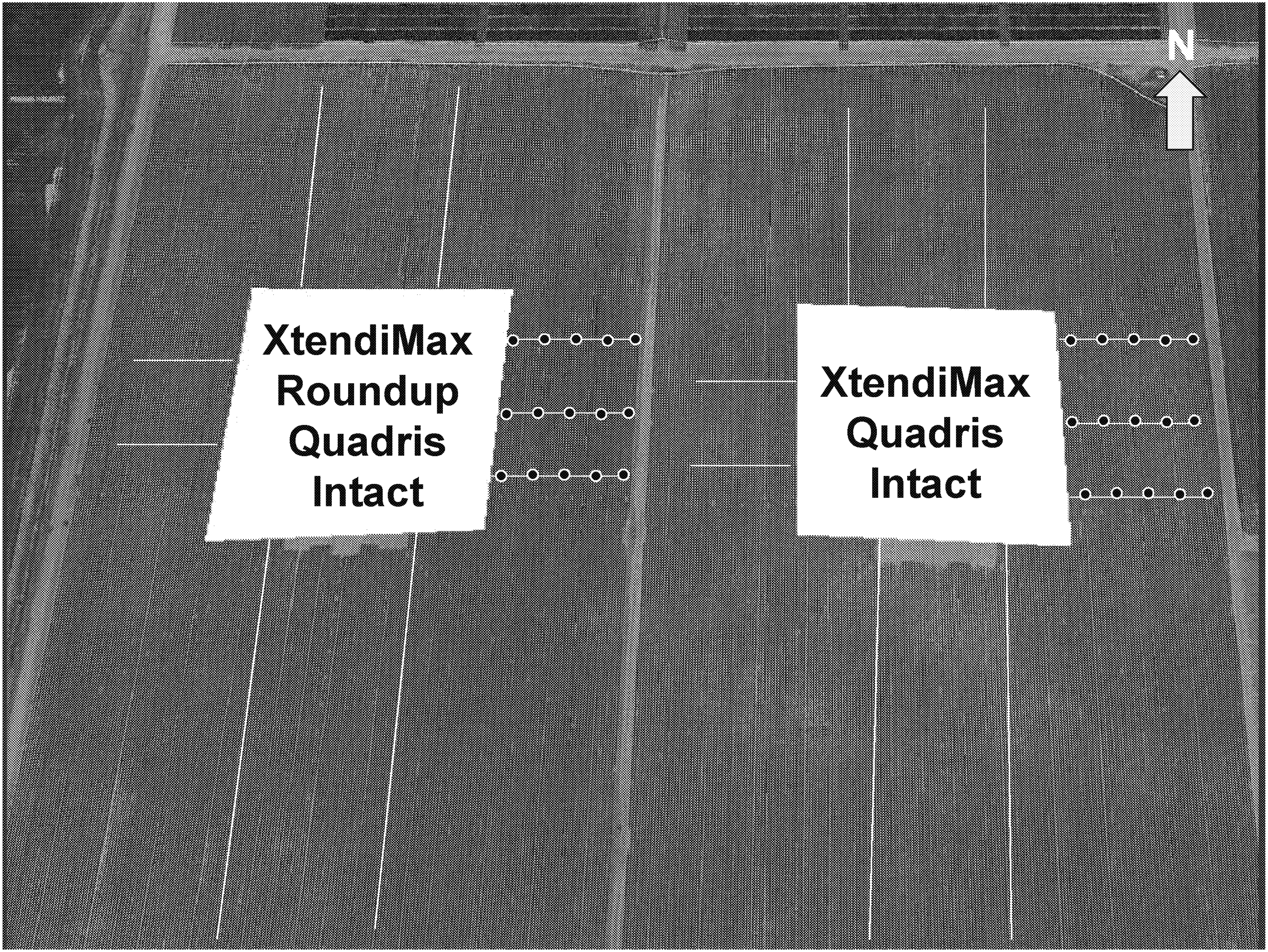
XtendiMax + Rdp Pmax + Warrant (4 days)

XtendiMax + Rdp PMax

pH of XtendiMax Spray Solutions

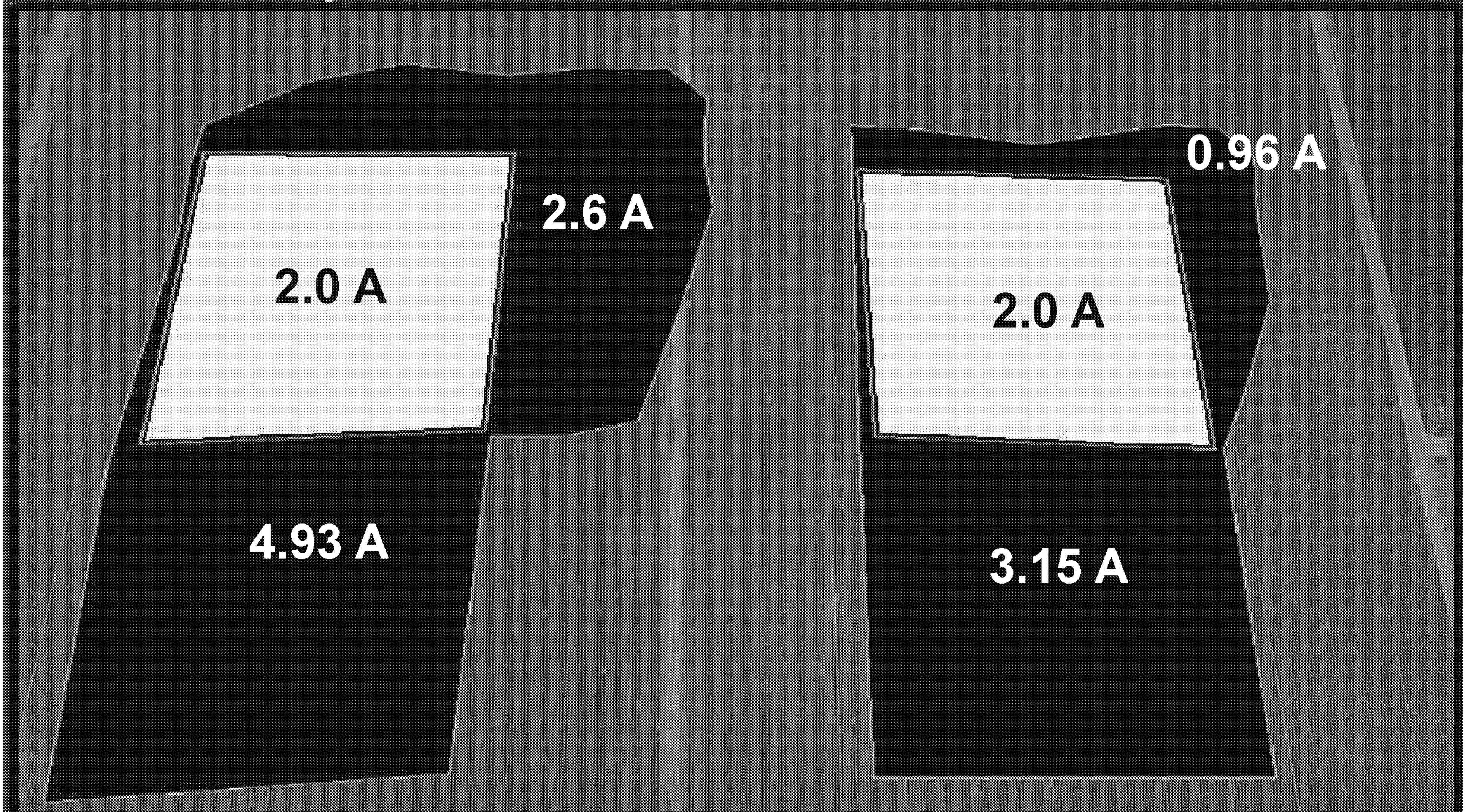


- Objectives: Determine if Roundup PowerMax increases off-target movement of XtendiMax
- Soybean: LibertyLink
- Applications:
  1. XtendiMax + Roundup PowerMax + Quadris + Intact
  2. XtendiMax + Quadris + Intact
- Date: August 13, 2018
- Sprayer setup:
  - 25 ft boom; 6 mph; 15 GPA, 24 inch height
  - TTI 11003 nozzles
- Environmental conditions:
  - Avg. 3.2 mph; range 0 to 5.7 mph
  - Daily max. 93 F

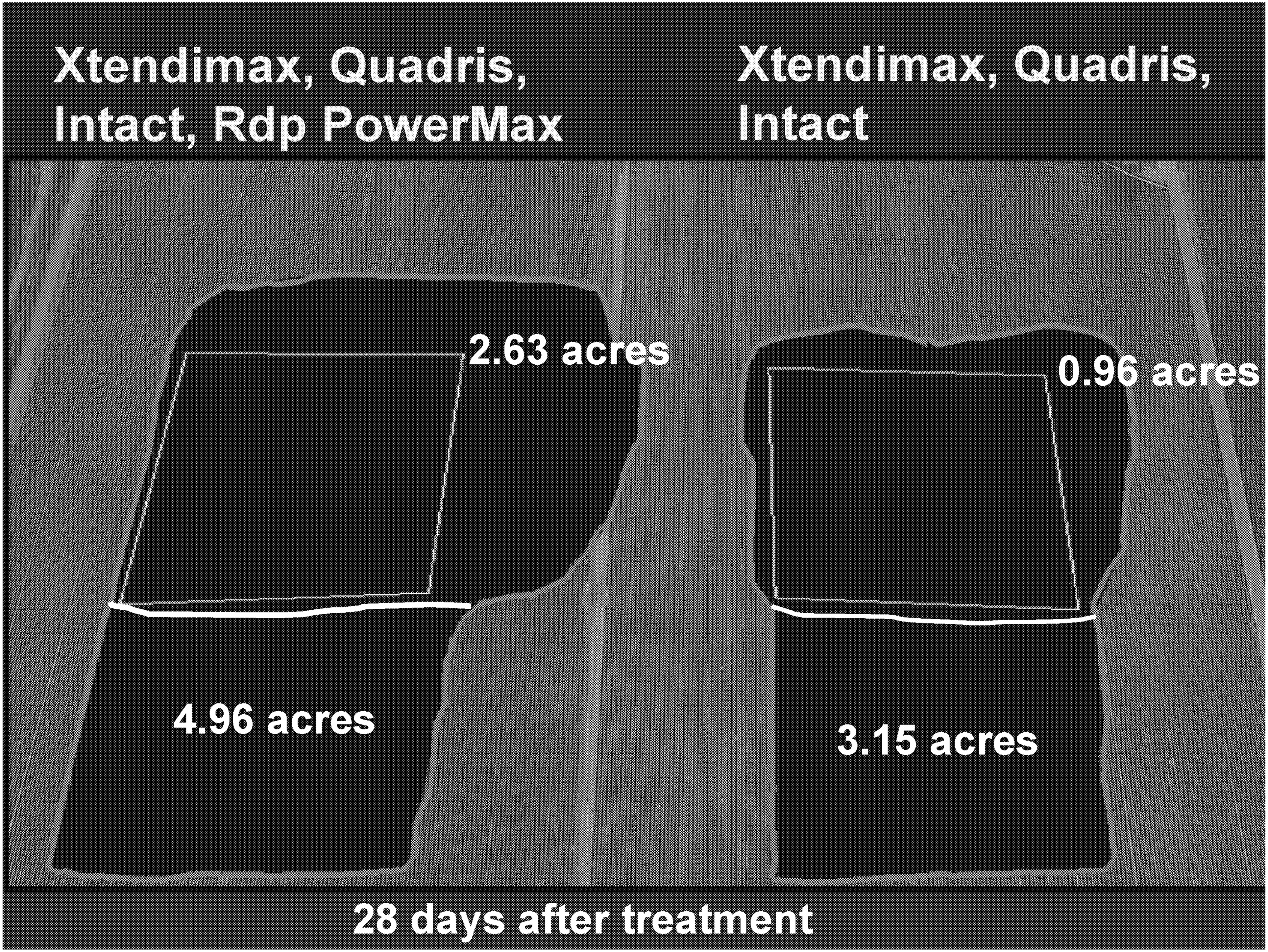

N
XtendiMax
Roundup
Quadris
Intact
XtendiMax
Quadris
Intact

Xtendimax, Quadris, Intact, Rdp PowerMax

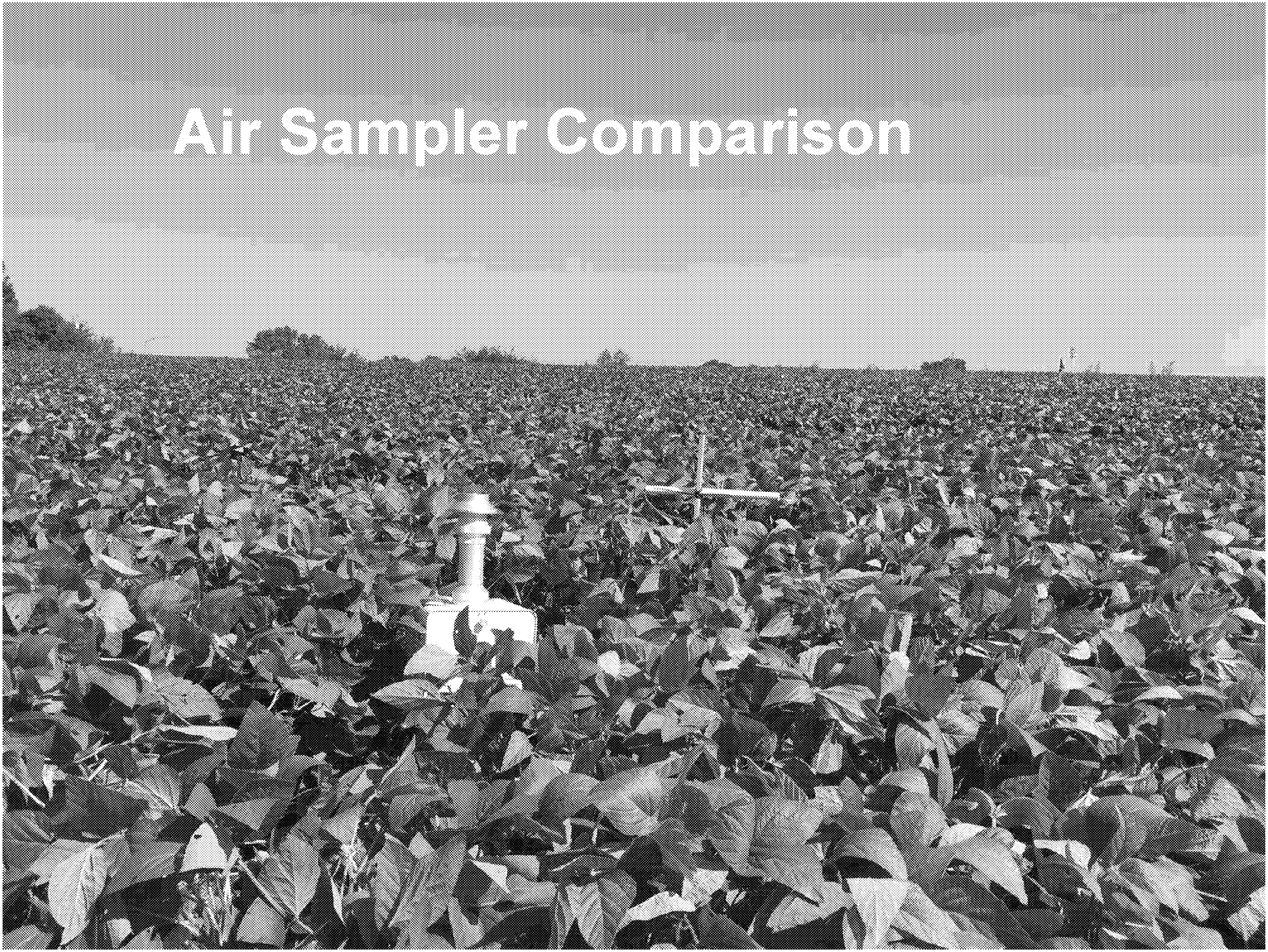
Xtendimax, Quadris, Intact

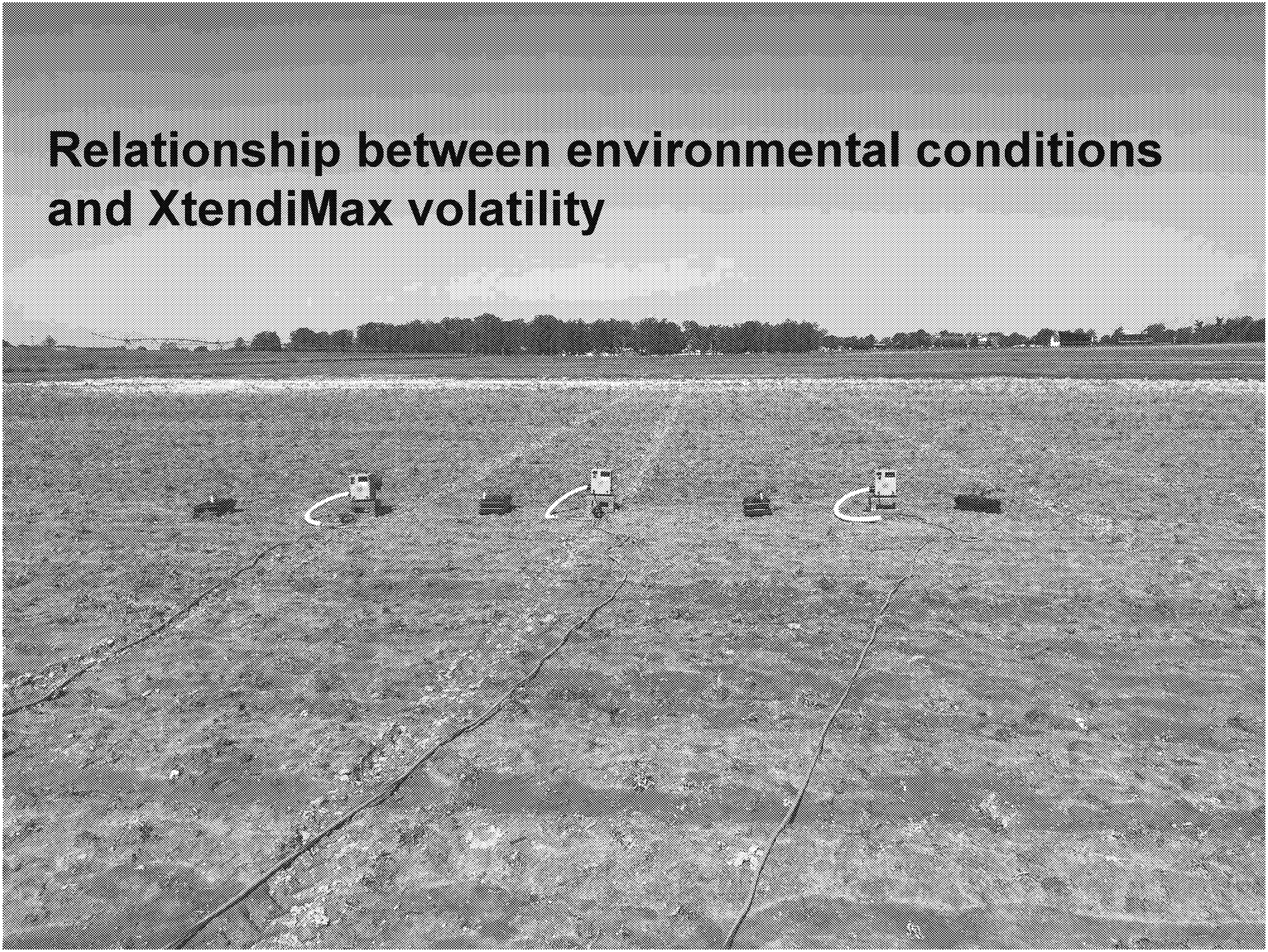


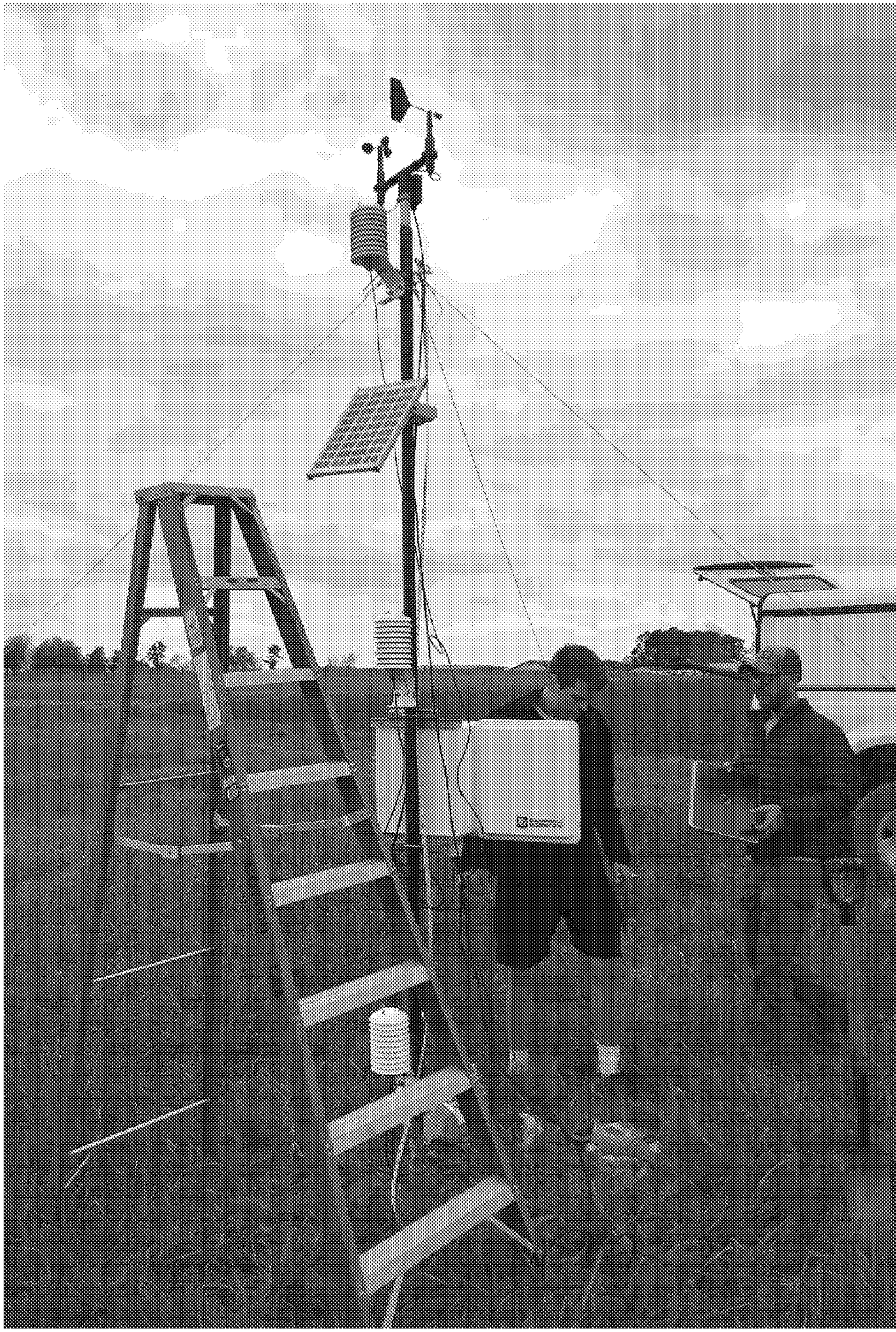
14 days after treatment


Xtendimax, Quadris,
Intact, Rdp PowerMax
Xtendimax, Quadris,
Intact
2.63 acres
0.96 acres
4.96 acres
3.15 acres
28 days after treatment

- Objective: Determine if non-Xtend soybean varieties differ in tolerance to drift rates of dicamba
- Location: Fayetteville, AR
- Rate: 1/250X
  (0.002 lb/A or 0.088 fl oz/A XtendiMax)
- Growth stage: V3 & R1


Air Sampler Comparison


Relationship between environmental conditions and XtendiMax volatility



Inversion Frequency

Mississippi County

Crittenden County

Lee County

Washington County

Conclusions thus far from 2018

- Damaged to soybean caused by Loyant was not a result of volatility
- Off-target damage caused by Enlist One is a result of physical drift or tank contamination
- Addition of Roundup PowerMax to dicamba products increases volatility and off-target movement
- Irrigation from tailwater recovery systems in areas where dicamba is used should be a concern
- Volatility continues to be a significant contributor to off-target movement of dicamba during the summer months

Additional On-going Projects

- Can SelectMax substitute for Roundup PowerMax as a dicamba tank-mix partner without increasing volatility?
- Does length of time in spray tank influence volatility?
- Does soil pH influence volatility of dicamba?
- Relationship between dicamba air concentration and symptomology on soybean?
- Influence of rainfall or irrigation on XtendiMax volatility

Encouragement through research

- Experimental dicamba is superior to XtendiMax & Engenia (Is this good enough?)
- The relationship between XtendiMax volatility and temperature in the field soon be better understood
  - Complicated by interaction with other factors
- Removing Roundup PowerMax from the spray and replacing with SelectMax
- Use of See-and-Spray will reduce off-target movement from physical drift and volatility

2018 Support

- Direct or indirect support
  - Mike & Dusty Carlson
  - U of A Systems Division of Agriculture
  - Arkansas State Plant Board
  - Northeast Research and Extension Center
  - Lon Mann Cotton Branch Station
  - Arkansas Agricultural Research Center
  - BASF, Corteva, & Bayer CropScience
  - United Soybean Board
- $350,000 spent on volatility research

Questions?

Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 10/4/2018 4:26:13 PM
To: Baris, Reuben [Baris.Reuben@epa.gov]
Subject: data
Attachments: Norsworthy_WSSA_Dicamba_Presentation.ppt; Data Across Locations (2017).xlsx; Environmental Application Agronomic Info (2017 trial).xls

Reuben,

Attached are the files associated with the 2017 Monsanto trials comparing XtendiMax and Engenia along with my WSSA presentation. The trials were conducted in Arkansas, Missouri, Tennessee, Nebraska, and Indiana.

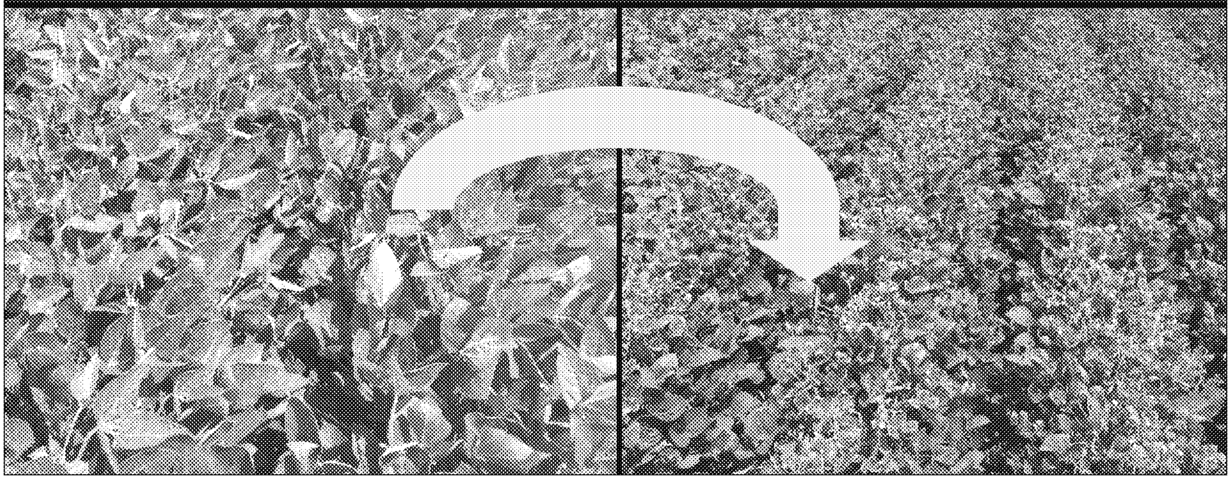
Let me know if you have questions. My administrative assistant will be sending you the Arkansas State Plant Board presentation that was given on September 20, 2018.

Regards,
Jason

Jason Norsworthy, PhD
Professor and Elms Farming Chair of Weed Science
1366 West Altheimer Dr.
Fayetteville, AR 72704
Tel: 479-575-8740
Mob: 479-313-1265

Secondary Movement of XtendiMax and Engenia in Drift Trials: Is this Volatility?

J.K. Norsworthy, G. Kruger, D. Reynolds, L. Steckel, K. Bradley, B. Young



HT3 Soybean – 2020

Glyphosate, Dicamba, Glufosinate

"I can't keep dicamba in the field"

July 18, 2017

Author: Larry Steckel, Extension Weed Specialist 1 Comment

"I can't keep dicamba in the field" has been a frequent comment I have heard from many frustrated folks who have followed the rules and tried their best not to drift on their neighbors. Quite a few good and conscientious farmers have thrown up their hands and gone back to Flexstar to try to control pigweed in soybean. Others have reported that they often have been successful not drifting onto non-target areas. However, judging by all the off-target dicamba injury that seems to be more the exception than the rule.

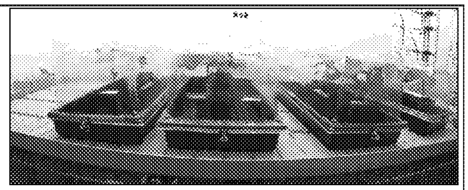
So what are the reasons for all the drift? After visiting hundreds of dicamba-drifted RR, LL and conventional soybean fields that easily have totaled over 30,000 acres, I can say with certainty that many of the reasons I have heard recently from upper management in Monsanto are NOT the cause of all these dicamba injured broadleaf plants across west Tennessee.

I cannot imagine the hundreds of thousands of acres of non dicamba tolerant (DT) soybeans in Tennessee that have shown dicamba injury could be due to contamination of Liberty jugs with dicamba, calcium deficiency, Dual Magnum burn, and/or surfactant burn. Nor do any of those reasons explain the dicamba injury I have seen in a vineyard, gardens, trees in parks and back yards…….even my backyard.

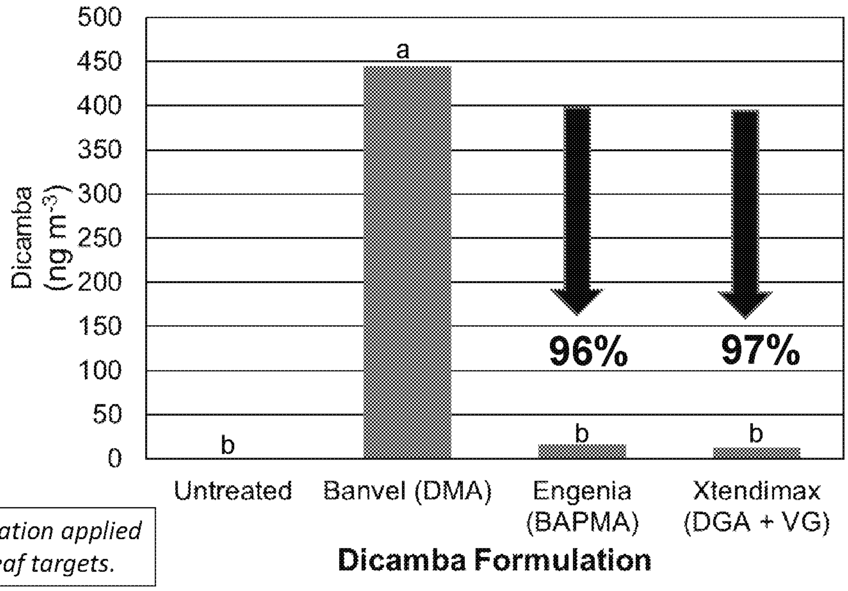
Dr. Larry Steckel

Herbicide Formulation

Vapor Chamber Experiment



Monsanto



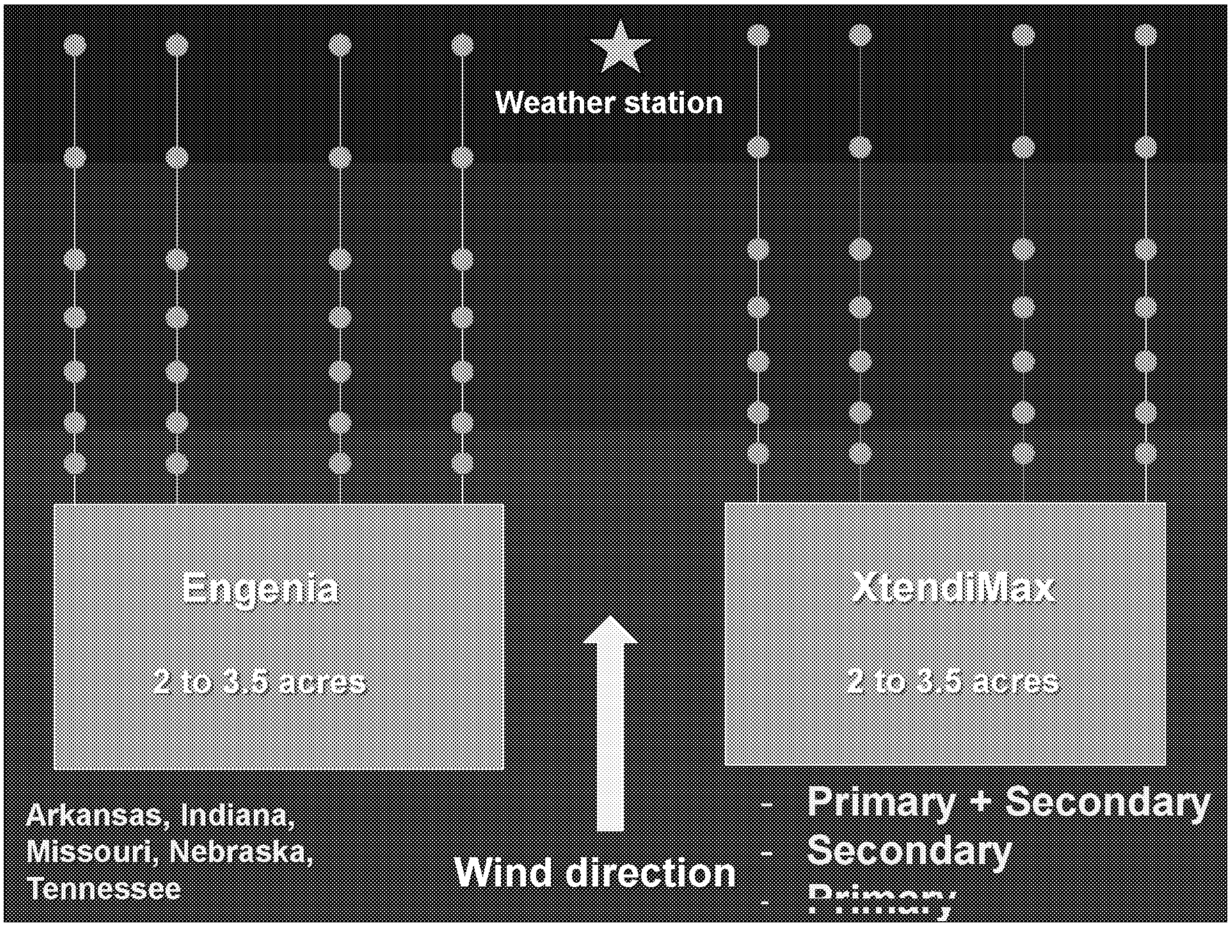
**Banvel formulation applied to soybean leaf targets.*

Dr. Bryan Young

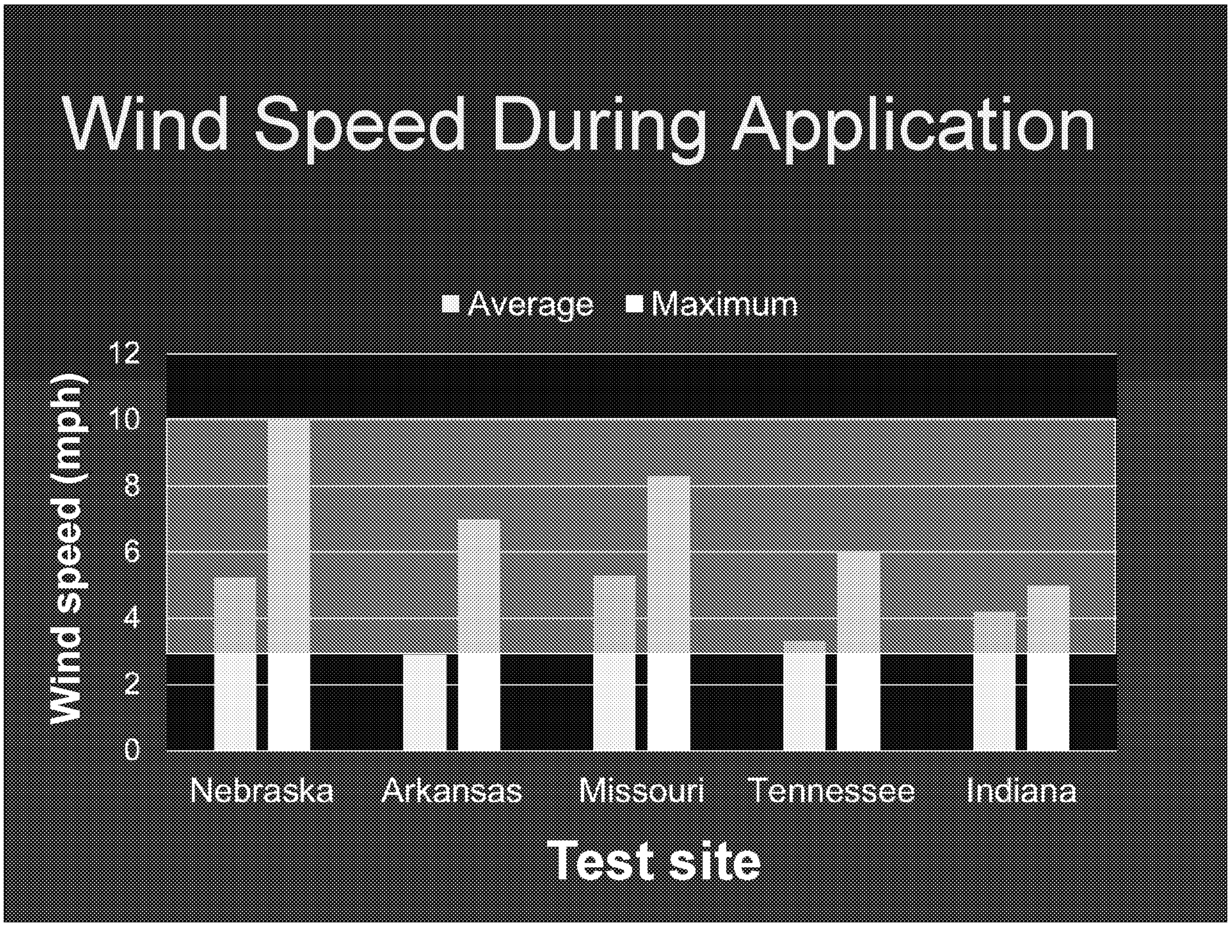
Objectives

- Assess off-target movement of Engenia and XtendiMax in field trials using labeled applications
- To determine if secondary movement contributes significantly to off-target movement of both formulations

Trial locations - 2017



Weather station
Engenia
2 to 3.5 acres
XtendiMax
2 to 3.5 acres
Arkansas, Indiana, Missouri, Nebraska, Tennessee
Wind direction
- Primary + Secondary
- Secondary


Wind Speed During Application
Average
Maximum
Wind speed (mph)
12
10
8
6
4
2
0
Nebraska
Arkansas
Missouri
Tennessee
Indiana
Test site

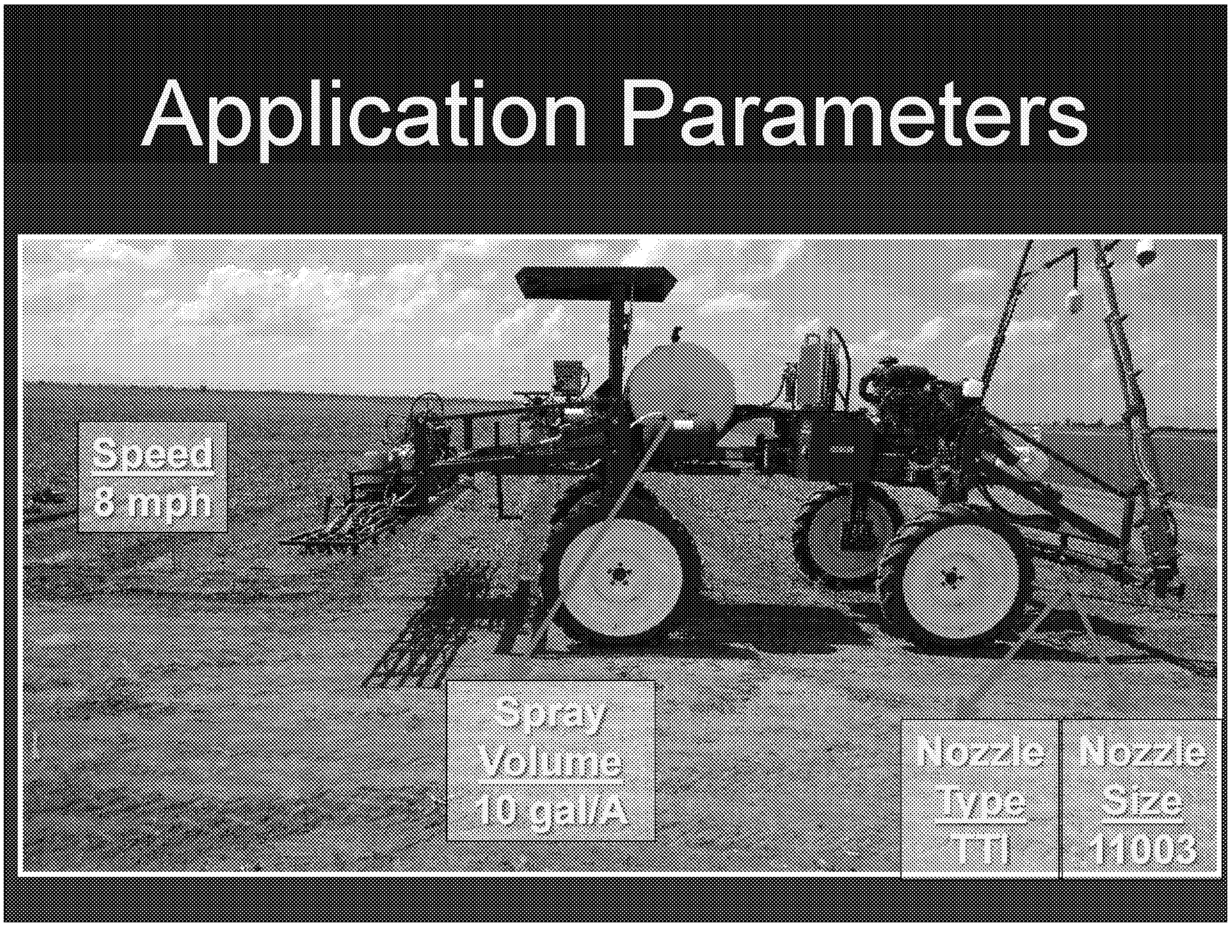
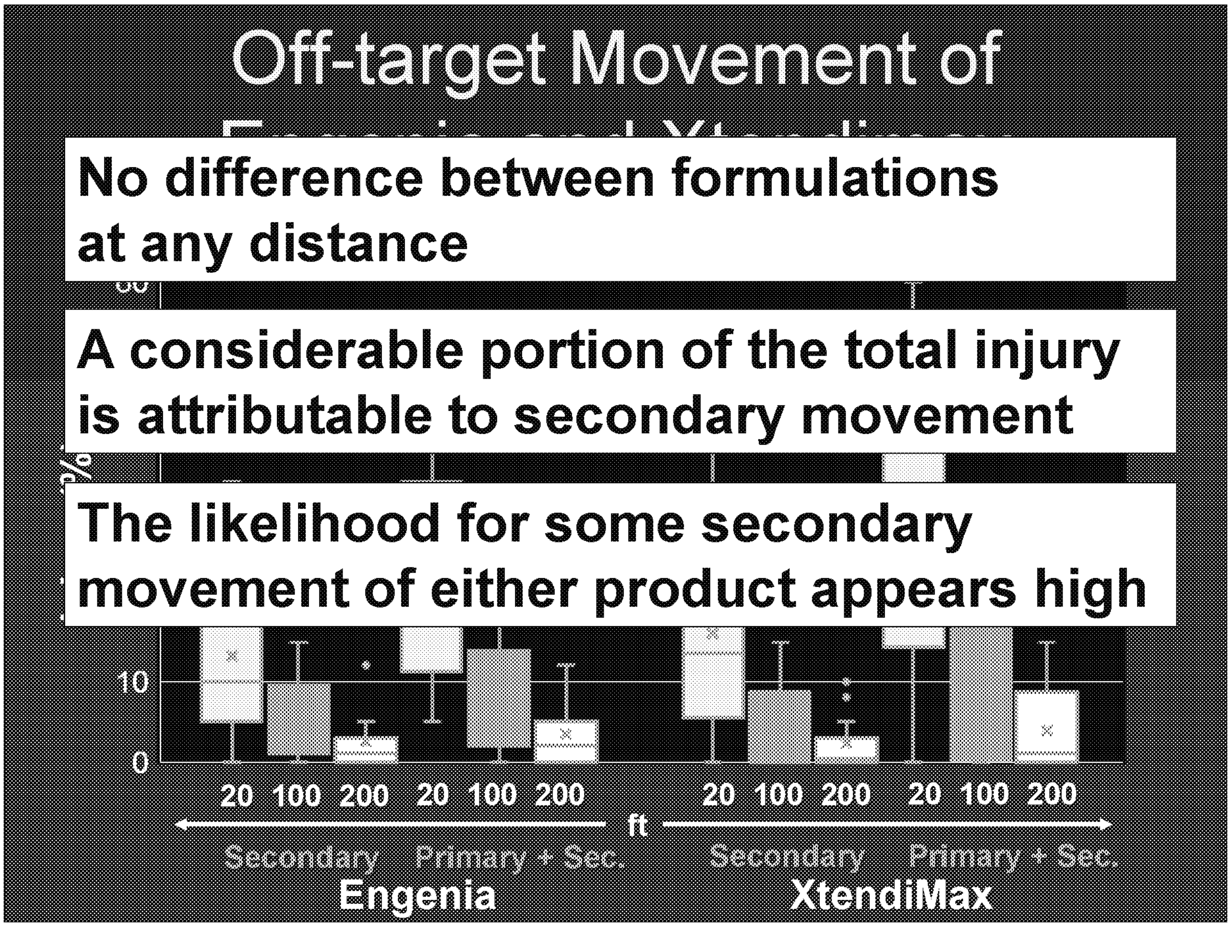
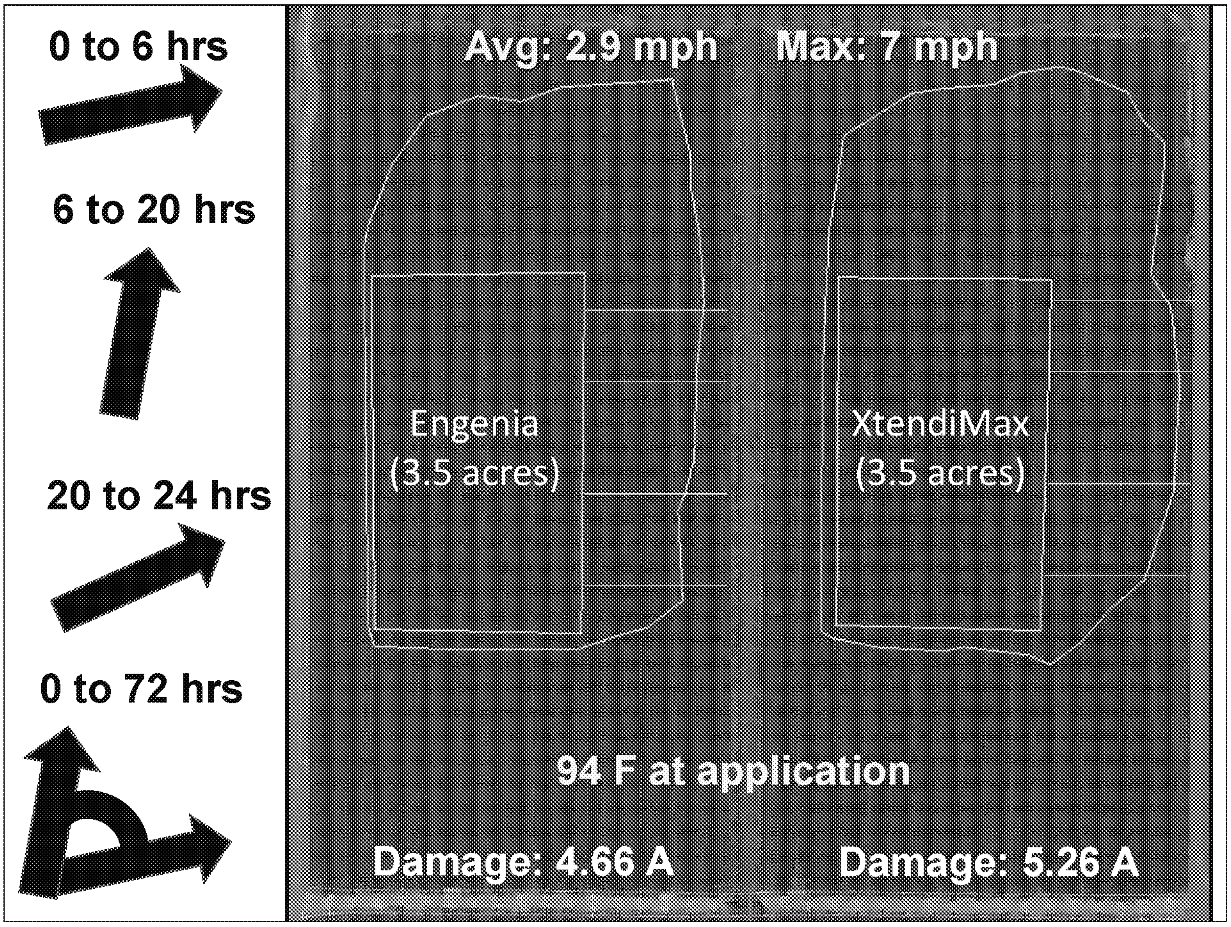
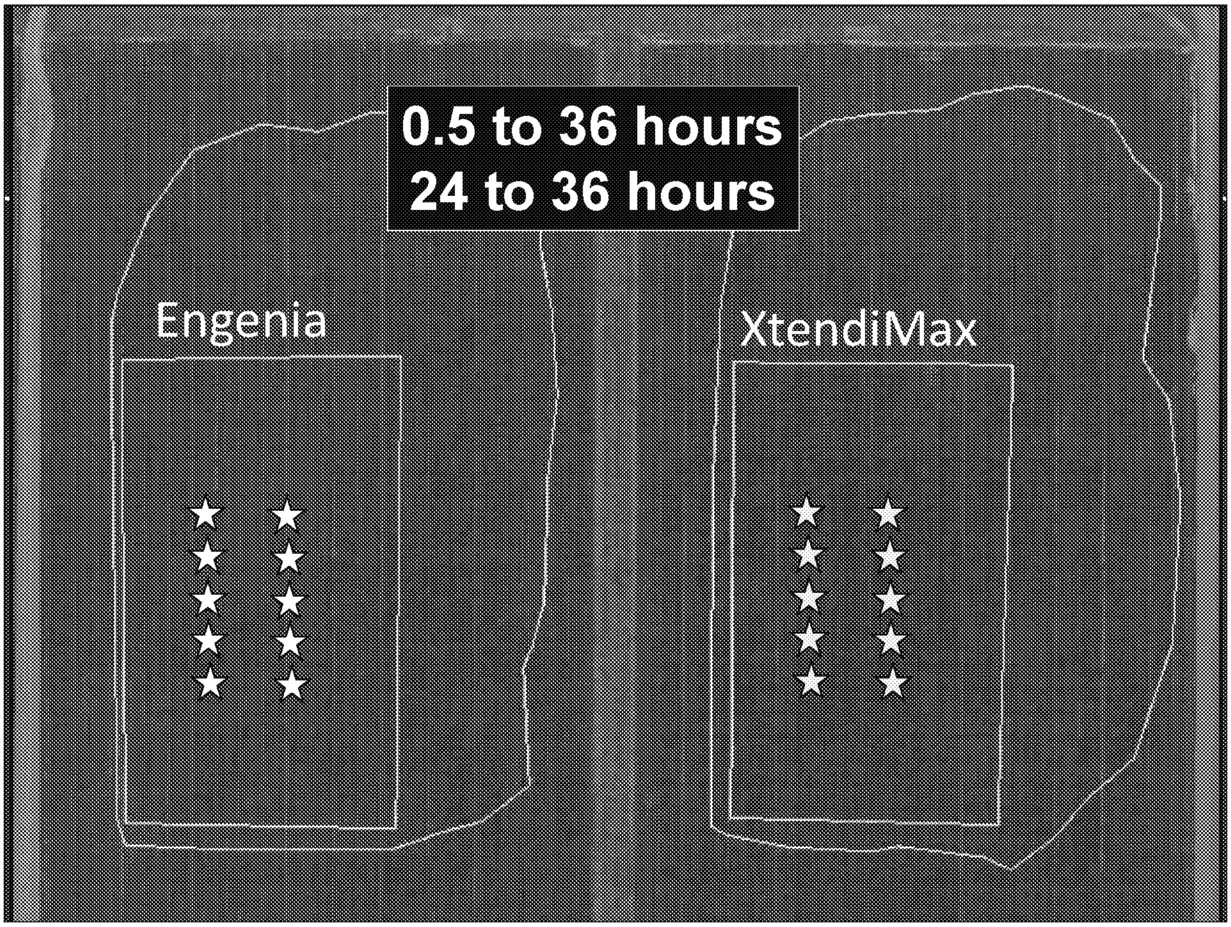


Image in background is a MudMaster. One of the sprayers used to apply treatments



Off-target Movement of
No difference between formulations at any distance
A considerable portion of the total injury is attributable to secondary movement
The likelihood for some secondary movement of either product appears high
10
0
20 100 200 20 100 200
20 100 200 20 100 200
ft
Secondary
Primary + Sec.
Secondary
Primary + Sec.
Engenia
XtendiMax


0 to 6 hrs
6 to 20 hrs
20 to 24 hrs
0 to 72 hrs
Avg: 2.9 mph
Max: 7 mph
Engenia
(3.5 acres)
XtendiMax
(3.5 acres)
94 F at application
Damage: 4.66 A
Damage: 5.26 A

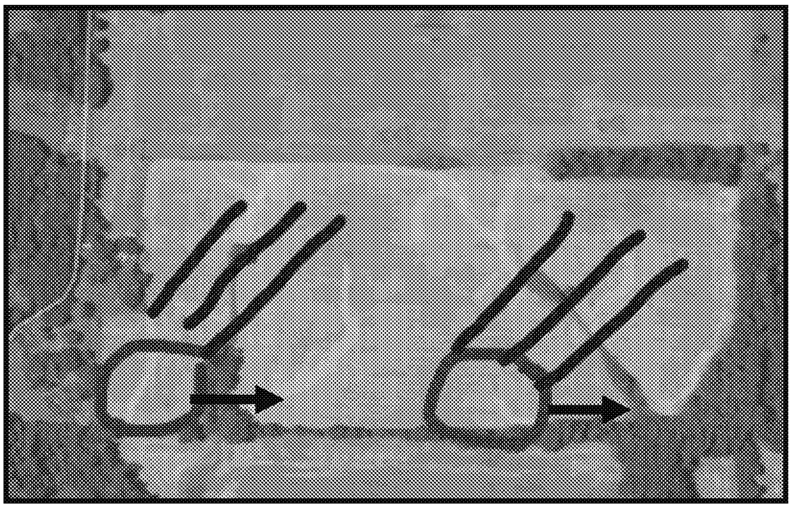

0.5 to 36 hours
24 to 36 hours
Engenia
XtendiMax

XtendiMax

0.5 to 36 hours 24 to 36 hours

Drift Showed up Against the Wind Direction when it was Sprayed

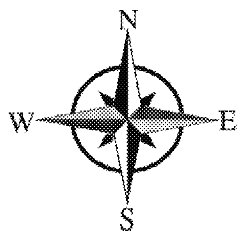
XtendiMax
+ Rdp Pmax + Intact



Engenia
+ Rdp Pmax

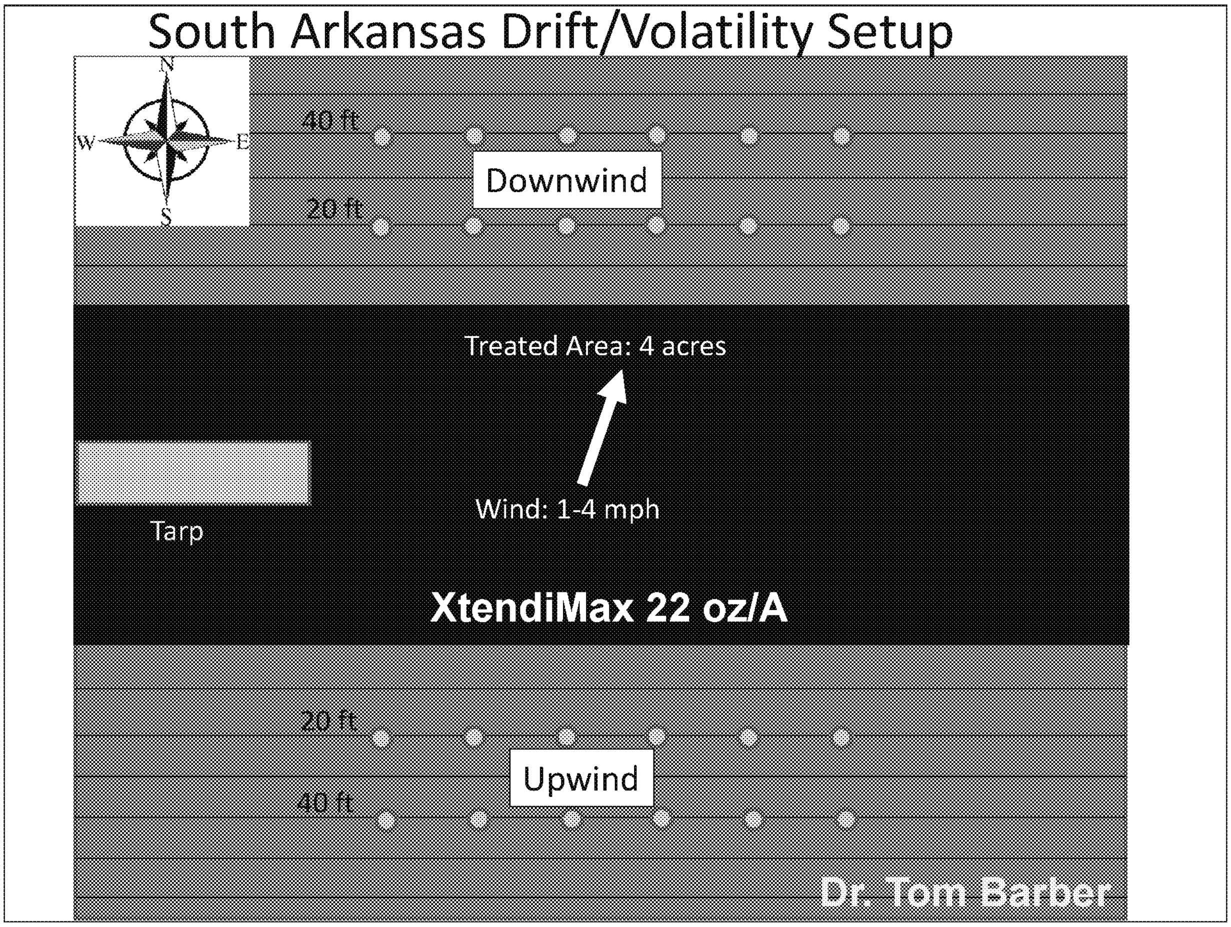
>2 hours

0 to 2 hours

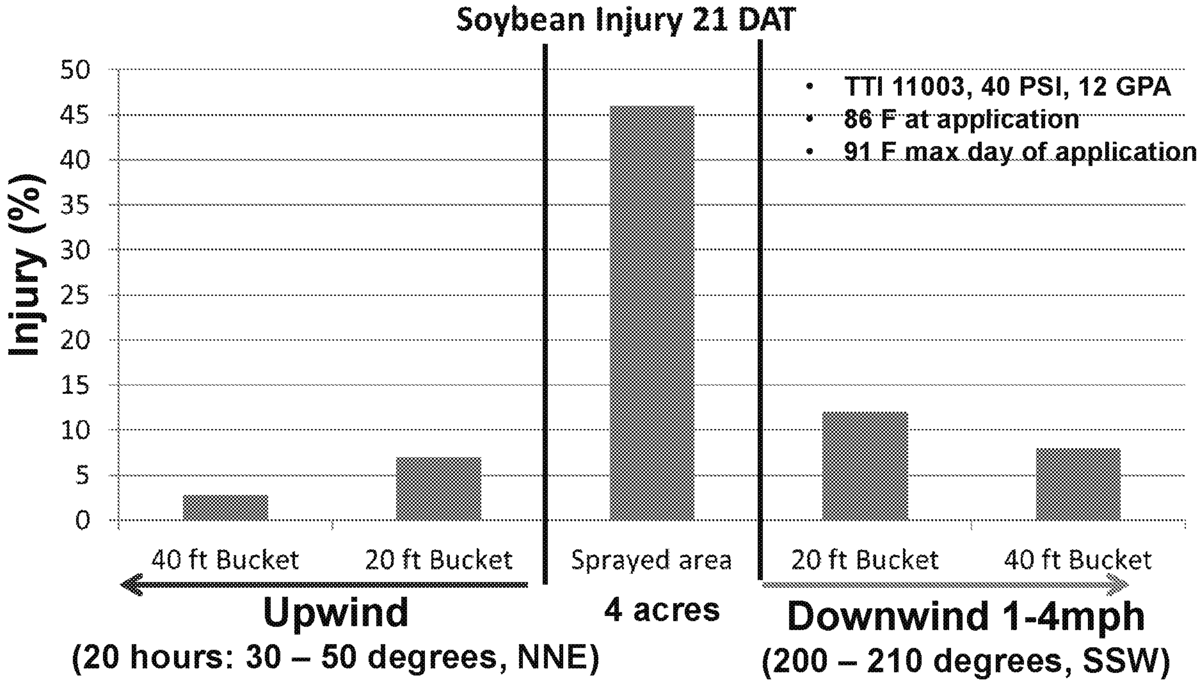


UTIA INSTITUTE OF AGRICULTURE
THE UNIVERSITY OF TENNESSEE

Dr. Larry Steckel


South Arkansas Drift/Volatility Setup
N
W
E
S
40 ft
Downwind
20 ft
Treated Area: 4 acres
Tarp
Wind: 1-4 mph
XtendiMax 22 oz/A
20 ft
Upwind
40 ft
Dr. Tom Barber

20-Acre Drift Study Southern Arkansas XtendiMax 22 oz/Acre



What Have We Learned?

- Volatility data based on laboratory trials do not match the degree of volatility in the field.
- Research from university weed scientists across the U.S. indicates newer forms of dicamba may volatilize at appreciable levels to cause injury to soybean.
- We can address physical drift through education, but secondary movement is more challenging to address.

ACCEPTED
11/09/2016
EPA Reg. No. 524-617

SUPPLEMENTAL LABELING

READ THE ENTIRE LABEL FOR XTENDIMAX™ WITH VAPORGRIP™ TECHNOLOGY BEFORE PROCEEDING WITH THE USE DIRECTIONS CONTAINED IN THIS SUPPLEMENTAL LABELING.

When using XtendiMax™ With VaporGrip™ Technology as permitted according to this supplemental labeling, read and follow all applicable directions, restrictions, and precautions on the container label and booklet provided with the product container and on this supplemental labeling. This supplemental labeling must be in the possession of the user at the time of pesticide application.

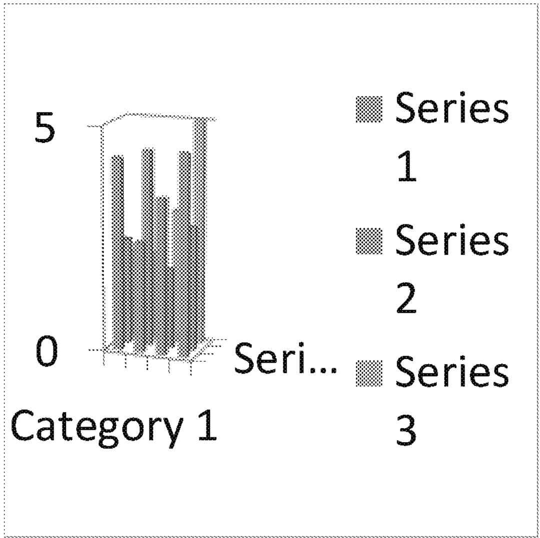
Label expires on 11/09/2018

What does a successful 2018 season look like?

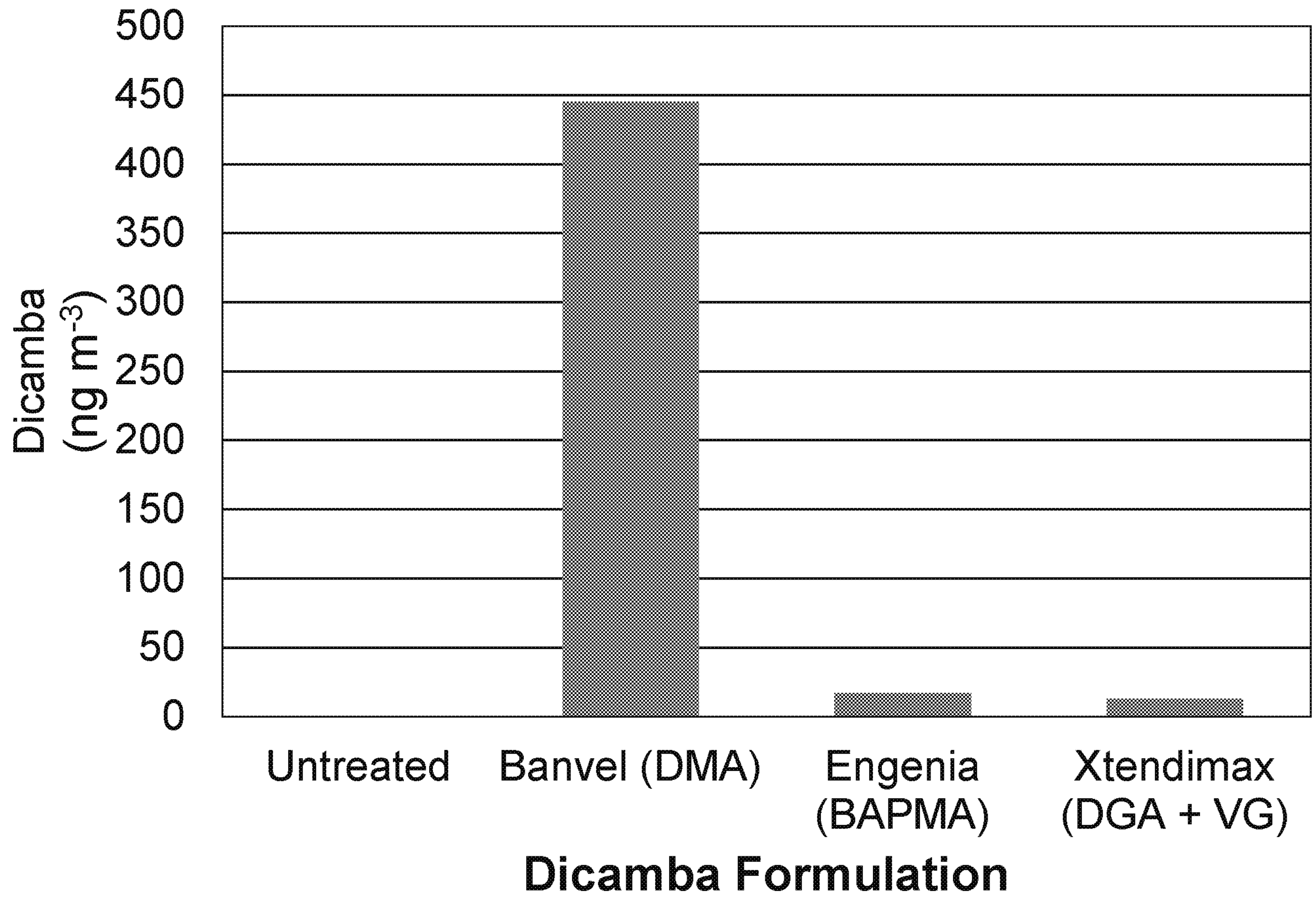
Keep out of reach of children
CAUTION!

In case of an emergency involving this product, call collect, day or night, 314-694-4000.

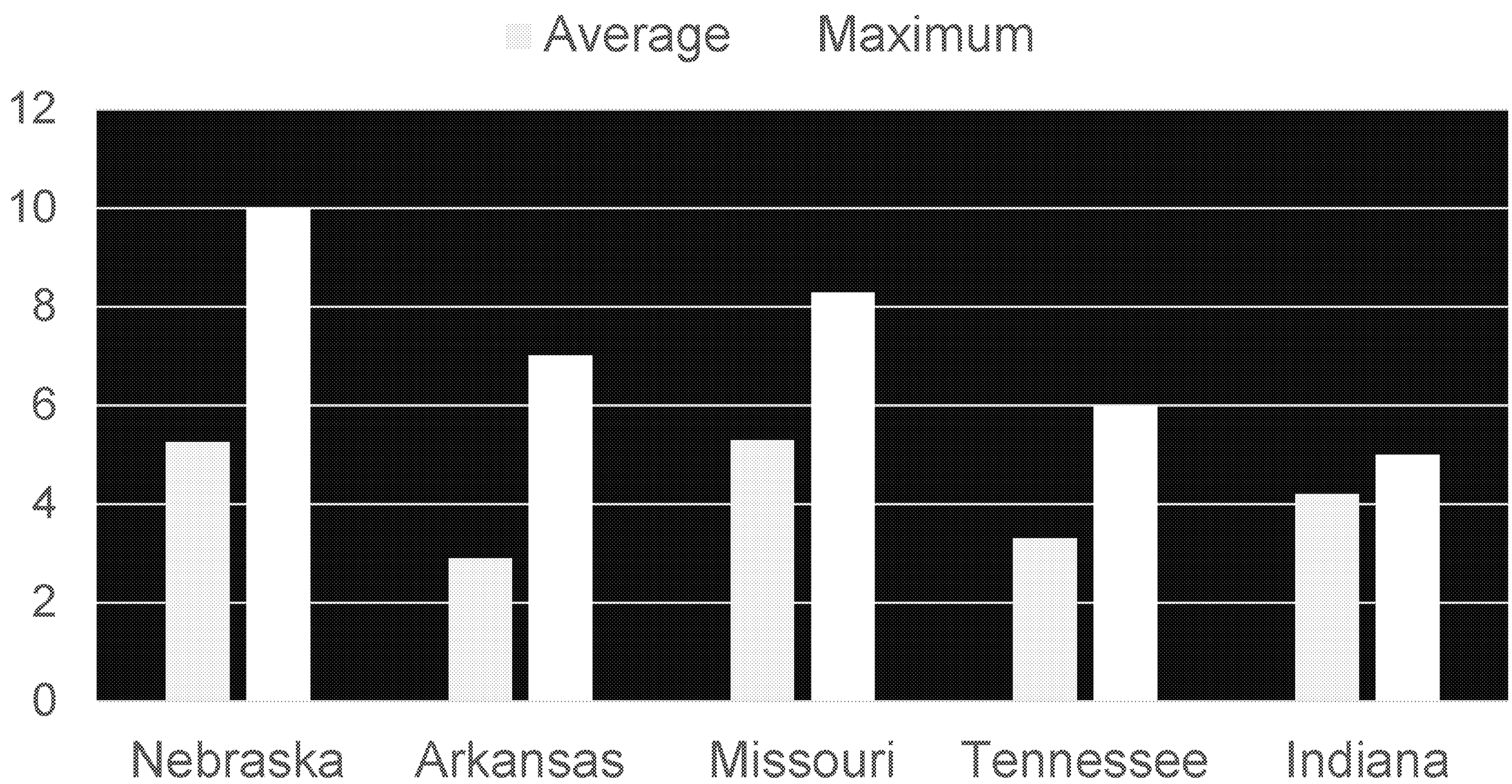
Questions?


5
0
Category 1
Seri...
Series 1
Series 2
Series 3

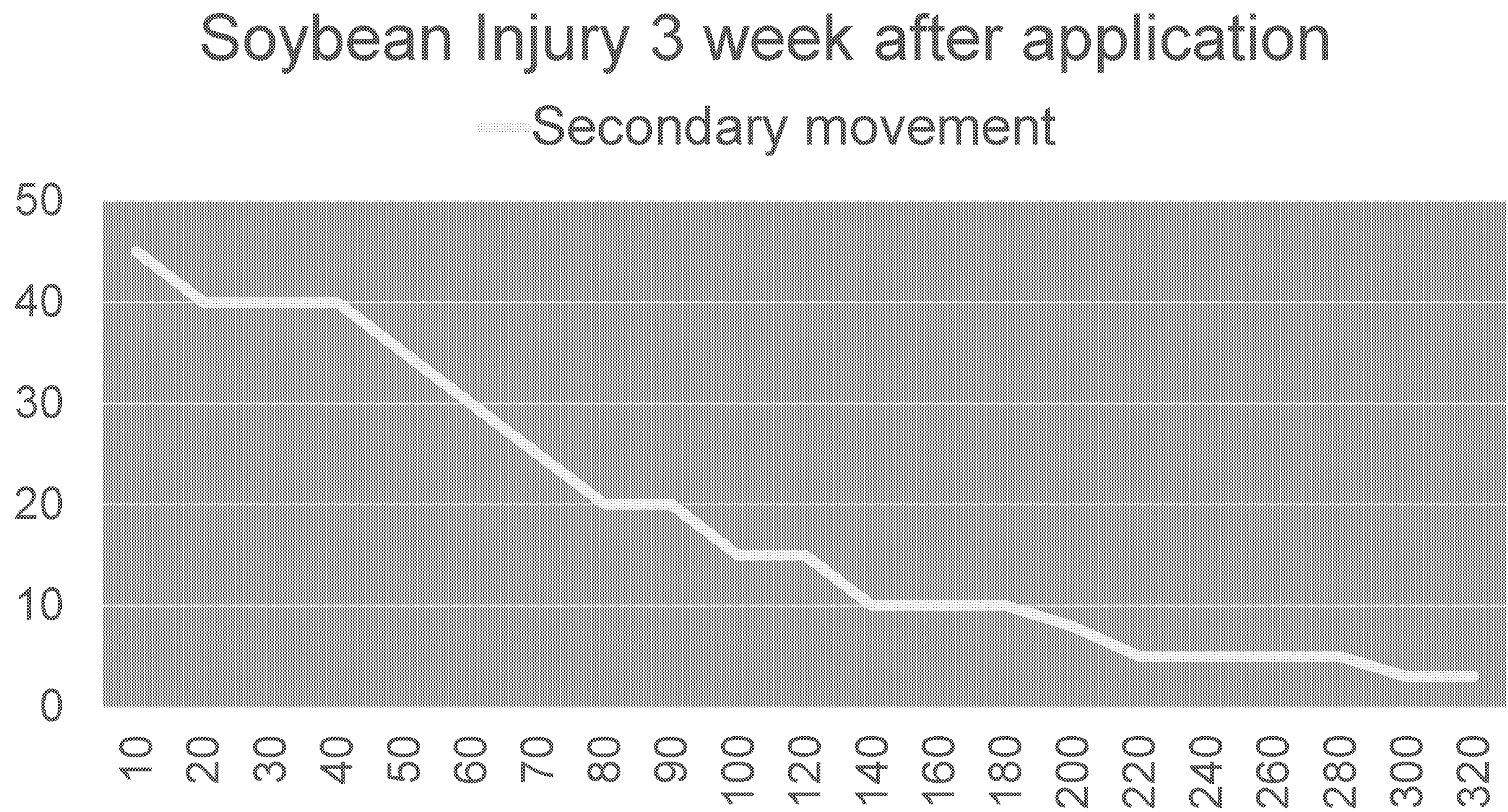
	Series 1	Series 2	Series 3
Category 1	4.3	2.4	2
Category 2	2.5	4.4	2
Category 3	3.5	1.8	3
Category 4	4.5	2.8	5


Dicamba (ng m-3)
500
450
400
350
300
250
200
150
100
50
0
Untreated
Banvel (DMA)
Engenia (BAPMA)
Xtendimax (DGA + VG)
Dicamba Formulation

formulation	Column1
Untreated	0
Banvel (DMA)	445
Engenia (BAPMA)	17
Xtendimax (DGA + VG)	13

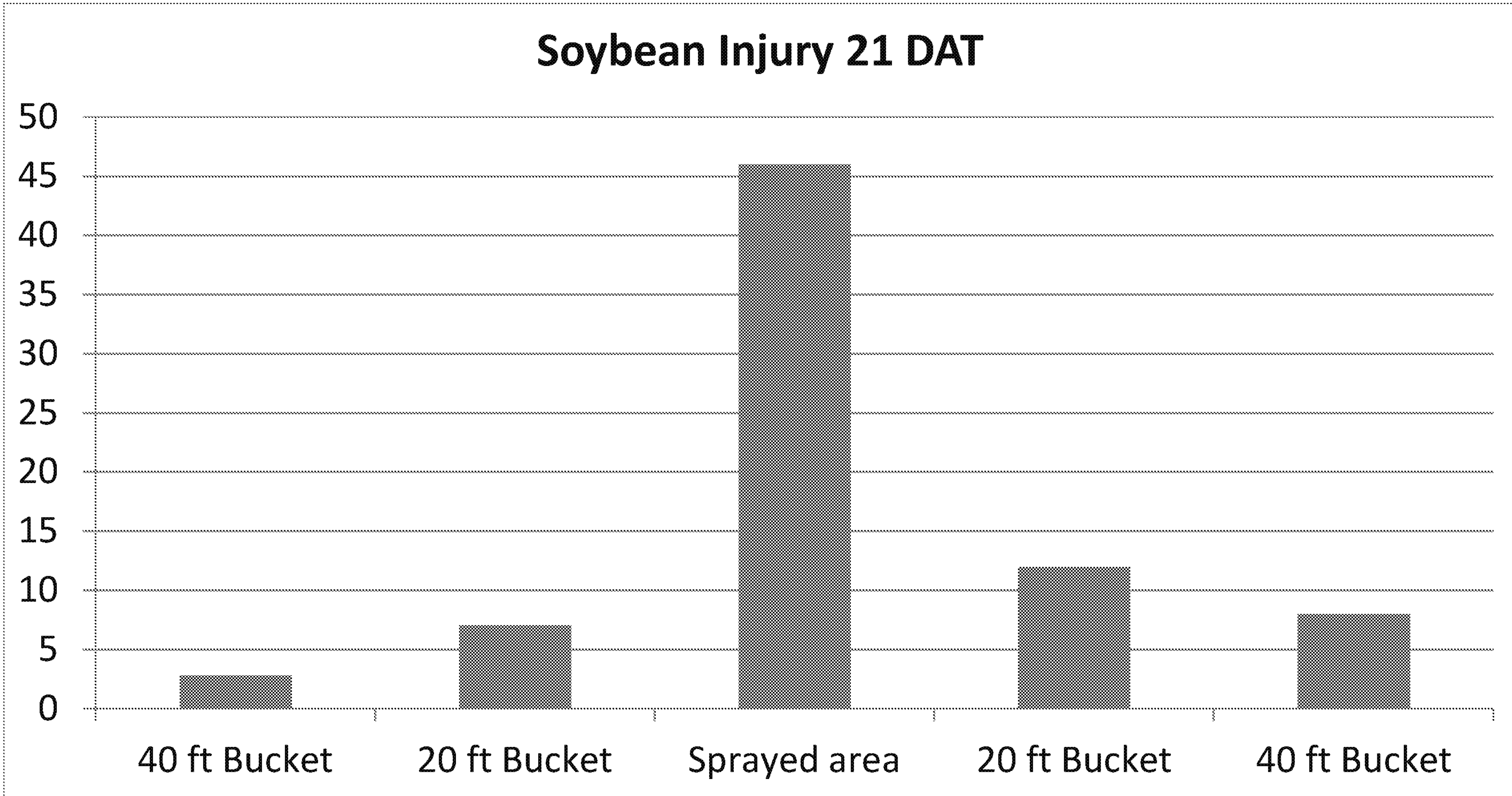

Average
Maximum
12
10
8
6
4
2
0
Nebraska
Arkansas
Missouri
Tennessee
Indiana

	Average	Maximum
Nebraska	5.25	10
Arkansas	2.9	7
Missouri	5.3	8.3
Tennessee	3.3	6
Indiana	4.2	5



Soybean Injury 3 week after application
Secondary movement
50
40
30
20
10
0
10
20
30
40
50
60
70
80
90
100
120
140
160
180
200
220
240
260
280
300
320

	Secondary movement
10	45
20	40
30	40
40	40
50	35
60	30
70	25
80	20
90	20
100	15
120	15
140	10
160	10
180	10
200	8
220	5
240	5
260	5
280	5
300	3
320	3


Soybean Injury 21 DAT
50
45
40
35
30
25
20
15
10
5
0
40 ft Bucket
20 ft Bucket
Sprayed area
20 ft Bucket
40 ft Bucket

	Soybean Injury	Series 2	Series 3
40 ft Bucket	2.8	2.4	2
20 ft Bucket	7	1.8	3
Sprayed area	46		
20 ft Bucket	12		
40 ft Bucket	8		

20.83333333	37.08333333	7.083333333	21.25

Message

From: Kenny, Daniel [Kenny.Dan@epa.gov]
Sent: 8/20/2018 1:08:49 AM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
CC: Baris, Reuben [Baris.Reuben@epa.gov]
Subject: Re: data

Thanks very much for your help, Jason. This really is very much appreciated.

Dan

Sent from my iPhone

On Aug 19, 2018, at 10:38 AM, Jason Keith Norsworthy <jnorswor@uark.edu> wrote:

> Dan and Reuben,
>
> All of the data from Travis' thesis is attached in the Excel file. It is sorted by chapter. Let me know if you have questions.
>
> Regards,
> Jason
>
> Jason Norsworthy, PhD
> Professor and Elms Farming Chair of Weed Science
> 1366 West Altheimer Dr.
> Fayetteville, AR 72704
> Tel: 479-575-8740
> Mob: 479-313-1265
>
> <Gordon Travis Jones - Thesis Data.xlsx>

Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 8/19/2018 2:38:33 PM
To: Kenny, Daniel [Kenny.Dan@epa.gov]; Baris, Reuben [Baris.Reuben@epa.gov]
Subject: data
Attachments: Gordon Travis Jones - Thesis Data.xlsx

Dan and Reuben,

All of the data from Travis' thesis is attached in the Excel file. It is sorted by chapter. Let me know if you have questions.

Regards,
Jason

Jason Norsworthy, PhD
Professor and Elms Farming Chair of Weed Science
1366 West Altheimer Dr.
Fayetteville, AR 72704
Tel: 479-575-8740
Mob: 479-313-1265

Message

From: Kenny, Daniel [Kenny.Dan@epa.gov]
Sent: 8/18/2018 12:40:51 AM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
CC: Baris, Reuben [Baris.Reuben@epa.gov]
Subject: Re: Raw Data

Thanks Jason! I very much appreciate your help!

Dan

Sent from my iPhone

On Aug 17, 2018, at 7:38 PM, Jason Keith Norsworthy <jnorswor@uark.edu> wrote:

> Hi Dan,
>
> I will try to get you the data next week. Travis, my former student, has the data. He told me today that he should be able to get it to me this weekend.
>
> Regards,
> Jason
>
> Sent from my iPhone
>
> On Aug 17, 2018, at 5:00 PM, Kenny, Daniel <Kenny.Dan@epa.gov> wrote:
>
>> Hi Jason. I hope all is well with you. We haven't talked for a while, so this is coming out of the blue, but I wondered if you might be in a position to help with a dicamba-related request. We have been looking at and are interested in a study entitled "Evaluation of Dicamba Off-Target Movement and Subsequent Effects on Soybean Offspring" by Gordon Travis Jones. Would you happen to know how and where we could get access to the raw data that supports this study? I think that might help in some current efforts here at the agency.
>>
>> Thanks very much for your help! I hope you're looking forward to a great weekend.
>>
>> Best regards,
>> Dan Kenny
>>
>> Daniel Kenny, Chief
>> Herbicide Branch
>> Registration Division
>> Office of Pesticide Programs
>> U.S. Environmental Protection Agency

Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 8/17/2018 11:38:03 PM
To: Kenny, Daniel [Kenny.Dan@epa.gov]
CC: Baris, Reuben [Baris.Reuben@epa.gov]
Subject: Re: Raw Data

Hi Dan,

I will try to get you the data next week. Travis, my former student, has the data. He told me today that he should be able to get it to me this weekend.

Regards,
Jason

Sent from my iPhone

On Aug 17, 2018, at 5:00 PM, Kenny, Daniel <Kenny.Dan@epa.gov> wrote:

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>
> Thanks very much for your help! I hope you're looking forward to a great weekend.
>
> Best regards,
> Dan Kenny
>
> Daniel Kenny, Chief
> Herbicide Branch
> Registration Division
> Office of Pesticide Programs
> U.S. Environmental Protection Agency

Message

From: Kenny, Daniel [Kenny.Dan@epa.gov]
Sent: 8/17/2018 10:00:17 PM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
CC: Baris, Reuben [Baris.Reuben@epa.gov]
Subject: Raw Data

Hi Jason. I hope all is well with you. We haven't talked for a while, so this is coming out of the blue, but I wondered if you might be in a position to help with a dicamba-related request. We have been looking at and are interested in a study entitled "Evaluation of Dicamba Off-Target Movement and Subsequent Effects on Soybean Offspring" by Gordon Travis Jones. Would you happen to know how and where we could get access to the raw data that supports this study? I think that might help in some current efforts here at the agency.

Thanks very much for your help! I hope you're looking forward to a great weekend.

Best regards,
Dan Kenny

Daniel Kenny, Chief
Herbicide Branch
Registration Division
Office of Pesticide Programs
U.S. Environmental Protection Agency

Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 8/17/2018 5:30:08 PM
To: Baris, Reuben [Baris.Reuben@epa.gov]
Subject: RE: Reference for Dicamba Thesis

Reuben,

I just called the student. He has graduated, but said he could resend me the data on tomorrow or Sunday. I will send you the JMP files and possibly Excel files when he sends them.

Regards,
Jason

Jason Norsworthy, PhD
Professor and Elms Farming Chair of Weed Science
1366 West Altheimer Dr.
Fayetteville, AR 72704
Tel: 479-575-8740
Mob: 479-313-1265

From: Baris, Reuben <Baris.Reuben@epa.gov>
Sent: Friday, August 17, 2018 11:38 AM
To: Jason Keith Norsworthy <jnorswor@uark.edu>
Subject: Fwd: Reference for Dicamba Thesis

Hey Jason,

Is it possible for you to share the raw data from your student's thesis?
Thanks
Reuben

Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 8/17/2018 5:17:59 PM
To: Baris, Reuben [Baris.Reuben@epa.gov]
Subject: Re: Reference for Dicamba Thesis

Yes. Any particular data chapter or all data?

Sent from my iPhone

On Aug 17, 2018, at 11:41 AM, Baris, Reuben <Baris.Reuben@epa.gov> wrote:

> Hey Jason,
>
> Is it possible for you to share the raw data from your student's thesis?
> Thanks
> Reuben
>
> <Evaluation of Dicamba Off-Target Movement and Subsequent Effects on Soybean Offspring.pdf>

Message

From: Baris, Reuben [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=A0181E3F02A246FC915A4AF026E249FC-BARIS, REUBEN]
Sent: 7/27/2018 12:37:59 AM
To: jnorswor@uark.edu
Subject: Fwd: Tour next week
Attachments: image002.jpg; ATT00001.htm; EPA Tour Agenda Iowa Stops 7.17.19.docx; ATT00002.htm

Sent from my iPhone

Begin forwarded message:

From: Greg Kruger <greg.kruger@unl.edu>
Date: July 24, 2018 at 5:39:08 PM CDT
To: "Sells.Dexter@epa.gov" <Sells.Dexter@epa.gov>, "tindall.kelly@epa.gov" <tindall.kelly@epa.gov>, "Horansky.Alex@epa.gov" <Horansky.Alex@epa.gov>, "hafner.sarah@epa.gov" <hafner.sarah@epa.gov>, "Farruggia.Frank@epa.gov" <Farruggia.Frank@epa.gov>, "Lantz.Tracy@epa.gov" <Lantz.Tracy@epa.gov>, "biggio.patricia@epa.gov" <biggio.patricia@epa.gov>, "Goodis.Michael@epa.gov" <Goodis.Michael@epa.gov>, "Baris.Reuben@epa.gov" <Baris.Reuben@epa.gov>, "Jill Schroeder" <Jill.Schroeder@ars.usda.gov>, Lee Van Wychen <Lee.VanWychen@wssa.net>, "Jones, Doug" <jones.doug@epa.gov>, "Green, Jamie" <Green.Jamie@epa.gov>, "Hackett, Shawn" <hackett.shawn@epa.gov>, "Gulliford, Jim" <gulliford.jim@epa.gov>, "Ridnour.Lacey@epa.gov" <Ridnour.Lacey@epa.gov>
Cc: Shannon Russell <srussell3@unl.edu>, Rick Robinson <rrobinson@ifbf.org>, Eric Gustafson <eric@imigroup.org>, Jeff Golus <jeff.golus@unl.edu>, "Kasey Schroeder" <kasey.schroeder@unl.edu>, Milos Zaric <milos.zaric@huskers.unl.edu>, bruno vieira <bruno.vieira@huskers.unl.edu>, Jesaelen Gizotti-de-Moraes <jesaelenmoraes@huskers.unl.edu>, Estefania Polli EOP / Ex. 6 Thomas Butts <tbutts@huskers.unl.edu>, Débora Latorre EOP / Ex. 6 "Guilherme Sousa Alves" EOP / Ex. 6, Tim Creger <tim.creger@nebraska.gov>
Subject: Tour next week

All,

I cannot believe how fast summer has gone! I can't wait to see all of you next week (this time on my home turf)!

In preparation for your trip to the Corn Husker State, I wanted to make sure that you all had the most updated itinerary (although it still seems to be shifting around a bit and may do so right up through the time you are here...). Please plan to bring good comfortable walking shoes because several of the stops will require walking in the fields. Also, please feel free to dress casually over the course of the week (see picture below for an example!). Please feel free to wear jeans, polos, or even tee shirts if you wish. The only day that will have any publicly open sessions will be Wednesday.

If anyone has any dietary restrictions, please let me know as soon as possible so that we can accommodate everyone as well as possible. We hope that you have a safe and enjoyable trip to Nebraska and look forward to showing you some good Midwestern hospitality. Should you need anything between now and then, please feel free to email, text or call me on my cell EOP / Ex. 6

Best wishes and GO BIG RED!,

Greg

Greg Kruger

Weed Science and Application Technology Specialist

University of Nebraska-Lincoln

West Central Research and Extension Center

402 West State Farm Road

North Platte, NE 69101

Ph: 308-696-6715

Email: gkruger2@unl.edu

EPA Tour

Day 1 – Travel to North Platte, NE (estimated arrival 1:24 CST at LBF) – Monday, July 30

Greg and members from his lab will be at the airport to pick up arriving guests. Box lunches will be provided on arrival.

2:45 – 5:00: Visit Dicamba Related Field Plots near Roscoe, NE

At this stop, we will see a large scale drift study set up to evaluate dicamba movement from physical particle drift and volatility. The stop will also highlight how common tank-contamination is as well as one example of an accident that resulted in "dicamba-like" symptomology. We will meet with Mark Nelson (Simplot Agronomist) to walk through applications and what has happened this year at that site and locally.

5:00 – 6:00: Check into Quality Inn – 12 rooms reserved - Austin Priest – 308-535-6166
6:00: Dinner at the (Kruger home) with Kruger Lab (Greg's Cell: EOP / Ex. 6
EOP / Ex. 6

This will be an informal and casual dinner at the Kruger Estate! ☺ Feel free to dress comfortably and be ready for a little local grilling from Chef Kruger himself!

Day 2 – Travel from North Platte, NE – Stay in Grand Island – Tuesday, July 31

8:00 – 11:00: Visit the West Central Research and Extension Center – checked out people mover w/Merle & wrote down in notebook (402 West State Farm Road)

Tour the Pesticide Application Technology Laboratory – We will spend the time talking about pesticide application technology research, drift research, and if time allowing we may even take a flight.

11:00 – 11:30: Travel to Gothenburg
11:30 – 1:00: Lunch (attempting to line up a lunch date with a couple of local agronomist and retail managers)

Nebraska Barn & Grill – 308-537-7463 – Diane for 30 people - 318 Platte River Road, Gothenburg

1:00 – 3:00: Visit the Monsanto Water Utilization Learning Center

At this stop, we will visit one of Monsanto's Learning Centers. The center is designed to provide pragmatic and practical scenarios for crop production in the High Plains. Our plan at this stop is to view the North Central Weed Science Society's Annual Weed Judging Contest plots which include Herbicide Mode-of-Action and Farm Problem Identification plots. We will be hosted by the Learning Center Director Dr. Brian Olson (former Weed Scientist with Kansas State University).

3:00 – 6:30: Travel to across south-central Nebraska

We will travel along the southern corridor of Nebraska with a sightseeing opportunity to view the crop production in that region of Nebraska. We will stop at Nebraskaland Avaiation where owner Tye Marquardt will give his perspective on crop protection from a retail business standpoint. We will have the chance to see an active mixing loading facility and some application equipment (if they are not active in the field). The operation includes both ground and aerial equipment.

6:30 – 7:30: Check in Grand Island – Fairfield Inn – 15 rooms reserved
Cheryl Gray – 308-381-8980 - 805 N. Allen Drive, Grand Island

7:30: Dinner with Commodity Boards – Texas Roadhouse – 308-382-0526 - 232 Wilmar Ave
Need to make reservations the day of – per Alisa on 6/19
Representatives from both the Nebraska Corn Board and Nebraska Soybean Board have been invited in. This will be a casual dinner where you can exchange ideas, concerns, and perspectives on the crop protection industry.

Day 3 – Travel from Grand Island, NE – Stay in Omaha – August 1

7:30 – 9:30: Travel to Lincoln

9:30 – 11:30: Open Stakeholder Meeting – East Campus Union

This will be an announced open stakeholder meeting for anyone in the public wishing to attend. We plan to direct the conversation towards dicamba, then atrazine and then on to any other topics that may be of interest as time permits

11:30 – 1:00: Lunch with UNL Representatives – Misty's Restaurant & Lounge – 6235 Havelock Ave., Lincoln – 402-466-8424 – NEED TO CALL BACK IN AN HOUR TO TALK TO A MANAGER – 7/16

This will be a quick lunch following the Open Stakeholder Meeting. A few of the senior administrators at UNL will join. They will be able to provide their perspective on the crop protection industry and how off-target movement of dicamba has changed things within UNL.

1:00 – 2:00: Travel to Springfield Soaring Wings Vineyard
2:00 – 5:00: Session at Soaring Wings Vineyard – 402-253-2479 – 17111 S 138th Street, Springfield
Session with State Regulators (Nebraska, Iowa, Kansas and Missouri)

For this part of the tour, there will be an overview of the winery with a chance to ask questions related to pest management, weed control and drift. Then we will shift the conversation to the state regulatory delegates in attendance from the four state region to discuss regulatory challenges, monitoring and reporting and other topics related to dicamba, atrazine and other herbicides of interest.

5:00 – 5:30: Travel to Omaha and Check in – Courtyard by Marriott - 15 rooms reserved
Joel Hendrickson - 402-346-2200 - 101 S 10th Street, Omaha

5:30 – 7:30: Dinner with State Regulators – Blatt Beer & Table North Downtown – 610 N 12th St., Omaha – 402-718-8822 – SEND EMAIL TO LARISSA TO MAKE RESERVATIONS

This will be an opportunity to continue the conversations from the winery over dinner. Darrick Steen from the Missouri Corn Growers Association will help facilitate the discussion.

Day 4 – Travel to Iowa Farms; Stay in Omaha – August 2

8:00 am – Depart hotel for Brent Lorimor Farm EOP / Ex. 6
9:00-11 am – Lorimor Farm "Walk-About"
Equipment Demonstrations & Displays
  - Tractor, sprayer, combine, drone, crop scouts, equipment dealer, field mapping demonstration

12:30-2 pm – Lunch at Twisted Tail Steakhouse & Saloon (2849 335th St, Logan, Iowa)
2:30-4 p.m. – Mike Busing Farm "Walk-About" EOP / Ex. 6

- Equipment Demonstrations & Displays
  - Tractor with GPS, RoGater self-propelled sprayer, tender truck, crop protection compound warehouse (packaging and handing discussion)

4:15 pm – Arrive Harrison County Herbicide Resistance Management Plot (300 feet west of the intersection of US highway 30 and Niagara Trail South)
Introductions by Larry Buss, Harrison County farmer; discussion & observations by weed resistance team

5:30 pm – Depart Weed Resistance Management Plot
6:30 pm – Arrive back at Courtyard by Marriott Hotel
7:30 pm – Dinner and Debriefing with EPA Staff with Rick Robinson, Greg Kruger and others that were in attendance over the course of the week.

Day 5 – Travel home (depart Omaha airport)


N
TM

Message

From: Baris, Reuben [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=A0181E3F02A246FC915A4AF026E249FC-BARIS, REUBEN]
Sent: 8/14/2018 10:08:27 AM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
Subject: Re: Wednesday meeting

I was wondering why he didn' t chime in yesterday. I' ll tell him it was Tom' s fault...

Sent from my iPhone

> On Aug 13, 2018, at 10:38 PM, Jason Keith Norsworthy <jnorswor@uark.edu> wrote:
>
> Reuben,
>
> You may want to add Kevin Bradley to your list of invitees. Somehow he was not included. Likely my oversight.
>
> Regards,
> Jason
>
> Sent from my iPhone

Message

From: Baris, Reuben [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=A0181E3F02A246FC915A4AF026E249FC-BARIS, REUBEN]
Sent: 8/8/2018 11:55:45 AM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
Subject: RE: List help

The invite should have come from Sandra O'Neil. She in our communications group.

REUBEN BARIS | PRODUCT MANAGER, TEAM 25 | HERBICIDE BRANCH
U.S. ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF PESTICIDE PROGRAMS | (703) 305-7356

From: Jason Keith Norsworthy [mailto:jnorswor@uark.edu]
Sent: Tuesday, August 07, 2018 8:57 PM
To: Baris, Reuben <Baris.Reuben@epa.gov>
Subject: Re: List help

Are you planning to visit with weed scientists in the coming week? It would be great to hear an update from each state. How was your NE visit?

Jason

Sent from my iPhone

On Aug 6, 2018, at 9:15 PM, Baris, Reuben <Baris.Reuben@epa.gov> wrote:

> Thanks Jason. What about the ones at the bottom. Or are you saying who we picked are the right folks? Thanks again.
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> Mi - Christie sort (??? Christie Sprague sprague1@msu.edu)
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>
> **From:** Jason Keith Norsworthy [mailto:jnorswor@uark.edu]
> **Sent:** Monday, August 06, 2018 6:36 PM
> **To:** Baris, Reuben <Baris.Reuben@epa.gov>
> **Subject:** Re: List help
>
> All of these appear correct.
>
> Jason
>
> Sent from my iPhone
>
> On Aug 6, 2018, at 4:12 PM, Baris, Reuben <Baris.Reuben@epa.gov> wrote:

Hey Jason,
Can you help fill in the gaps from Dan's chicken scratch? Thank you.

IA, Bob Hartzler hartzler@iastate.edu
MS, Jason Bond jason.bond@msstate.edu
OH, Mark Loux loux.1@osu.edu
MN, Jeff Gonsulus gunso001@umn.edu
ND, Tom Peters Thomas.J.Peters@ndsu.edu
SD, Sharon Clay sharon.clay@sdstate.edu
KS, Dallas Peterson dpeterso@ksu.edu
OK, Todd Baughman todd.baughman@okstate.edu
LA, Daniel Stephenson DStephenson@agcenter.lsu.edu
TX, Scott Nolte scott.nolte@tamu.edu
AL, Steve Li xzl0004@auburn.edu
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SC, Mike Marshall marsha3@clemson.edu
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Still to figure out from Dan R.'s list:
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Sent: 8/8/2018 1:10:53 AM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
Subject: Re: List help

That's the plan. I'm a little disappointed how hastily it was thrown together but at least it bring that group into the conversation again.

Nebraska was very different in many ways to the mid south but also much of the same.

Sent from my iPhone

On Aug 7, 2018, at 8:56 PM, Jason Keith Norsworthy <jnorswor@uark.edu> wrote:

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Sent: 8/7/2018 12:45:35 PM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
Subject: RE: List help

Thanks. Looks like I'll be on the line.

REUBEN BARIS | PRODUCT MANAGER, TEAM 25 | HERBICIDE BRANCH
U.S. ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF PESTICIDE PROGRAMS | (703) 305-7356

From: Jason Keith Norsworthy [mailto:jnorswor@uark.edu]
Sent: Tuesday, August 07, 2018 8:19 AM
To: Baris, Reuben <Baris.Reuben@epa.gov>
Subject: Re: List help

4:30 EST

Sent from my iPhone

On Aug 7, 2018, at 6:22 AM, Baris, Reuben <Baris.Reuben@epa.gov> wrote:

> No I wasn't invited. But I talked with Lee about it when I was in nebraska. When is the call?
>
> Sent from my iPhone
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> On Aug 7, 2018, at 7:10 AM, Jason Keith Norsworthy <jnorswor@uark.edu> wrote:
>
>> You can add tbarber@uaex.edu.
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>> Will you be on the WSSA call today with Nancy Beck and others from EPA?
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The ones at the bottom are correct except Greg Armel. I think JD Green should be your Kentucky contact. Greg Armel works for BASF unless he has changed positions.

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Pa- ? (??? Dwight Lingenfelter dxl18@psu.edu)

REUBEN BARIS | PRODUCT MANAGER, TEAM 25 | HERBICIDE BRANCH
U.S. ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF PESTICIDE PROGRAMS
| (703) 305-7356

From: Jason Keith Norsworthy [mailto:jnorswor@uark.edu]
Sent: Monday, August 06, 2018 6:36 PM
To: Baris, Reuben <Baris.Reuben@epa.gov>
Subject: Re: List help

All of these appear correct.

Jason

Sent from my iPhone

On Aug 6, 2018, at 4:12 PM, Baris, Reuben <Baris.Reuben@epa.gov> wrote:

> Hey Jason,
> Can you help fill in the gaps from Dan's chicken scratch?
> Thank you.
>
> IA, Bob Hartzler hartzler@iastate.edu
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Message

From: Baris, Reuben [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=A0181E3F02A246FC915A4AF026E249FC-BARIS, REUBEN]
Sent: 8/7/2018 2:35:20 AM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
Subject: RE: List help

One was missing….want me to add Barber? ☺

AR

REUBEN BARIS | PRODUCT MANAGER, TEAM 25 | HERBICIDE BRANCH
U.S. ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF PESTICIDE PROGRAMS | (703) 305-7356

From: Jason Keith Norsworthy [mailto:jnorswor@uark.edu]
Sent: Monday, August 06, 2018 10:27 PM
To: Baris, Reuben <Baris.Reuben@epa.gov>
Subject: Re: List help

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> **To:** Baris, Reuben <Baris.Reuben@epa.gov>
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Message

From: Baris, Reuben [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=A0181E3F02A246FC915A4AF026E249FC-BARIS, REUBEN]
Sent: 8/7/2018 2:29:50 AM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
Subject: RE: List help

Ok . Thanks.

REUBEN BARIS | PRODUCT MANAGER, TEAM 25 | HERBICIDE BRANCH
U.S. ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF PESTICIDE PROGRAMS | (703) 305-7356

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Message

From: Baris, Reuben [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=A0181E3F02A246FC915A4AF026E249FC-BARIS, REUBEN]
Sent: 8/7/2018 2:15:07 AM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
Subject: RE: List help

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REUBEN BARIS | PRODUCT MANAGER, TEAM 25 | HERBICIDE BRANCH
U.S. ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF PESTICIDE PROGRAMS | (703) 305-7356

From: Jason Keith Norsworthy [mailto:jnorswor@uark.edu]
Sent: Monday, August 06, 2018 6:36 PM
To: Baris, Reuben <Baris.Reuben@epa.gov>
Subject: Re: List help

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Jason

Sent from my iPhone

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Message

From: Baris, Reuben [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=A0181E3F02A246FC915A4AF026E249FC-BARIS, REUBEN]
Sent: 8/6/2018 9:11:56 PM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
Subject: List help

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Sent: 9/13/2018 4:26:45 PM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
Subject: formal request

Hey Jason,
This is the formal request, if you're willing, to share the data from your Proctor, AR study on the 240 acre, 80 acre block study.

Happy to discuss more by phone if necessary to talk about mechanisms for sharing with EPA.
Reuben

REUBEN BARIS | PRODUCT MANAGER, TEAM 25 | HERBICIDE BRANCH
U.S. ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF PESTICIDE PROGRAMS | (703) 305-7356

Message

From: Baris, Reuben [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=A0181E3F02A246FC915A4AF026E249FC-BARIS, REUBEN]
Sent: 9/13/2018 3:25:04 PM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
Subject: RE: PI's for various studies

Thank you.

Reuben Baris | Product Manager, Team 25 | Herbicide Branch
U.S. Environmental Protection Agency, Office of Pesticide Programs | (703) 305-7356

From: Jason Keith Norsworthy [mailto:jnorswor@uark.edu]
Sent: Thursday, September 13, 2018 10:59 AM
To: Baris, Reuben <Baris.Reuben@epa.gov>
Subject: RE: PI's for various studies

See below response.

From: Baris, Reuben <Baris.Reuben@epa.gov>
Sent: Thursday, September 13, 2018 9:09 AM
To: Jason Keith Norsworthy <jnorswor@uark.edu>
Subject: PI's for various studies

Hey Jason,
Please review the list below and ensure I'm contacting the correct PI's for any data/study requests. Thanks. Reuben

Proctor, AR – Dr. Jason Norsworthy
Indiana – Dr. Bryan Young
Michigan – Dr. Christy Sprague
Nebraska – Dr. Greg Kruger
Wisconsin – Dr. Rodrigo Werle

Other studies/research:
Tennessee – Dr. Larry Steckel (Monsanto conducted the trial, but Dr. Larry Steckel observed the results)
Alabama – Dr. Steve Li

Separate from Monsanto – Dr. Tom Mueller at Tennessee has a wealth of data on XtendiMax
Dr. Kevin Bradley also has some XtendiMax volatility research but not with Monsanto

Message

From: Baris, Reuben [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=A0181E3F02A246FC915A4AF026E249FC-BARIS, REUBEN]
Sent: 10/11/2018 6:08:21 PM
To: Rodrigo Werle [rwerle@wisc.edu]; Young, Bryan G [BryanYoung@purdue.edu]; Greg Kruger [greg.kruger@unl.edu]; sprague1@msu.edu; Reynolds, Dan [dreynolds@pss.msstate.edu]
CC: Peck, Charles [peck.charles@epa.gov]; Jason Keith Norsworthy [jnorswor@uark.edu]
Subject: Large-scale dicamba studies: question RE: tank mixes

Drs. Werle, Young, Kruger, Sprague, Reynolds and Norsworthy:

I hope these are easy questions for you all. If you don't want to cc the whole group on this email, you can respond directly to me.

1) What were the tank mix(es) you used in your study for xtendimax off-target movement?
 - specifically, was acetochlor (e.g., warrant or other product) used?

2) Were there were any (notable) deviations that they made to the protocol when conducting the study

Thanks for your quick reply.
Reuben

REUBEN BARIS | PRODUCT MANAGER, TEAM 25 | HERBICIDE BRANCH
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Message

From: Baris, Reuben [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=A0181E3F02A246FC915A4AF026E249FC-BARIS, REUBEN]
Sent: 10/26/2018 11:09:42 PM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
Subject: Re: Air sample and filter paper data

Thanks.
Reuben

Sent from my iPhone

On Oct 26, 2018, at 6:49 PM, Jason Keith Norsworthy <jnorswor@uark.edu> wrote:

Reuben,

Attached please find the air sample puff and filter paper data that were collected at Proctor, AR (XtendiMax drift/volatility trial). Dr. Ashli Brown at MS State University analyzed the samples and sent me these data. Let me know if you have questions.

Regards,
Jason

Jason Norsworthy, PhD
Professor and Elms Farming Chair of Weed Science
1366 West Altheimer Dr.
Fayetteville, AR 72704
Tel: 479-575-8740
Mob: 479-313-1265

<Norsworthy AR Air Sample and Filter Paper Data Proctor AR (EPA).xlsx>

Message

From: Baris, Reuben [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=A0181E3F02A246FC915A4AF026E249FC-BARIS, REUBEN]
Sent: 9/13/2018 7:41:50 PM
To: Jason Norsworthy [jnorswor@uark.edu]
Subject: Fwd: Proctor, Arkansas

Early reads from our modelers...

Are you able to answer Chuck's question?

Sent from my iPhone

Begin forwarded message:

> **From:** "Peck, Charles" <Peck.Charles@epa.gov>
> **Date:** September 13, 2018 at 3:39:12 PM EDT
> **To:** "Baris, Reuben" <Baris.Reuben@epa.gov>, "Corbin, Mark" <Corbin.Mark@epa.gov>
> **Cc:** "Odenkirchen, Edward" <Odenkirchen.Edward@epa.gov>, "Echeverria, Marietta" <Echeverria.Marietta@epa.gov>
> **Subject: RE: Proctor, Arkansas**
>
> Hi Reuben,
>
> Can you confirm with Dr. Norsworthy that in the "Proctor_Dicamba_Weather_CR300Series_TableOUT.xlsx" file, the WindDir0 and WindSpd0 correspond to the samplers at height 0.15 m, WindDir1 and WindSpd1 correspond to samplers at height 0.33 m, etc? and that these are met conditions at the center mast?
>
> Thanks! Interesting stuff!
>
> Chuck Peck
> OPP/EFED/ERB VI
> Potomac Yard South
> Crystal City, VA
> Room 10244
> (703) 347-8064
> peck.charles@epa.gov
>
> ---
>
> **From:** Baris, Reuben
> **Sent:** Thursday, September 13, 2018 3:25 PM
> **To:** Corbin, Mark <Corbin.Mark@epa.gov>
> **Cc:** Odenkirchen, Edward <Odenkirchen.Edward@epa.gov>; Peck, Charles <Peck.Charles@epa.gov>; Echeverria, Marietta <Echeverria.Marietta@epa.gov>
> **Subject:** Re: Proctor, Arkansas
>
> Don't know timing. Only sent out requests this week.
>
> Sent from my iPhone
>
> On Sep 13, 2018, at 3:16 PM, Corbin, Mark <Corbin.Mark@epa.gov> wrote:

Thanks

I can give it a quick look tomorrow. Chuck is off

Looking at it on my phone it
Definitely looks interesting. Similar methods to Jones with distinction between primary (I assume drift) and secondary (I assume volatility) using tarps.

Do you have a sense when the other data might be coming?

Mark

Sent from my iPhone

On Sep 13, 2018, at 2:49 PM, Baris, Reuben <Baris.Reuben@epa.gov> wrote:

> Mark,
> This is the first of a few emails on additional data.
>
> I know you have a lot of things going on, but can you all screen this and make a call if this or anything like this would be helpful/informative.
>
> Note this study has accompanying air sampling (see protocol previously shared) but has not yet been completed. I expect to receive similar submissions from Wisconsin, Indiana, Michigan, and Nebraska.
> Thank you.
> Reuben
>
> REUBEN BARIS | PRODUCT MANAGER, TEAM 25 | HERBICIDE BRANCH
> U.S. ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF PESTICIDE PROGRAMS
> | (703) 305-7356
>
> **From:** Jason Keith Norsworthy [mailto:jnorswor@uark.edu]
> **Sent:** Thursday, September 13, 2018 2:30 PM
> **To:** Baris, Reuben <Baris.Reuben@epa.gov>
> **Subject:** RE: formal request
>
> Reuben,
>
> Attached please find the assessments collected from the large-plot trial that I conducted in conjunction with Monsanto at Proctor, AR. Dr. Ashley Brown from MS State University is analyzing the air sample data collected from this trial. I have attached some slides that should help explain what was observed at this location. Let me know if you need anything else or have questions about the trial.
>
> Regards,
> Jason
>
> Jason Norsworthy, PhD
> Professor and Elms Farming Chair of Weed Science

1366 West Altheimer Dr.
Fayetteville, AR 72704
Tel: 479-575-8740
Mob: 479-313-1265

From: Baris, Reuben <Baris.Reuben@epa.gov>
Sent: Thursday, September 13, 2018 11:27 AM
To: Jason Keith Norsworthy <jnorswor@uark.edu>
Subject: formal request

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Reuben

Reuben Baris | Product Manager, Team 25 | Herbicide Branch
U.S. Environmental Protection Agency, Office of Pesticide Programs
| (703) 305-7356

<EPA Proctor slides (PDF).pdf>

<Monsanto large drift Proctor data_.xlsx>

<Proctor_Dicamba_Weather_CR300Series_TableOUT.xlsx>

Message

From: Baris, Reuben [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=A0181E3F02A246FC915A4AF026E249FC-BARIS, REUBEN]
Sent: 9/13/2018 6:53:47 PM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
Subject: RE: formal request

Interesting.

I thought all of these studies were on Xtendimax. I plan to call Dan.

Thanks again.
reuben

REUBEN BARIS | PRODUCT MANAGER, TEAM 25 | HERBICIDE BRANCH
U.S. ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF PESTICIDE PROGRAMS | (703) 305-7356

From: Jason Keith Norsworthy [mailto:jnorswor@uark.edu]
Sent: Thursday, September 13, 2018 2:50 PM
To: Baris, Reuben <Baris.Reuben@epa.gov>
Subject: RE: formal request

According to Dan Reynolds, she should have the BASF samples completed soon and then she will begin the Monsanto samples. I don't know how long that will take. Between BASF and Monsanto, there are hundreds of samples that are being analyzed (probably 1,000 or more total). You may try reaching out to Dan Reynolds (dreynolds@pss.msstate.edu). He is the one overseeing air samples coming into MS State. All universities are sending samples to Brown's lab this summer. I will share the results just as soon as they become available.

Jason Norsworthy, PhD
Professor and Elms Farming Chair of Weed Science
1366 West Altheimer Dr.
Fayetteville, AR 72704
Tel: 479-575-8740
Mob: 479-313-1265

From: Baris, Reuben <Baris.Reuben@epa.gov>
Sent: Thursday, September 13, 2018 1:43 PM
To: Jason Keith Norsworthy <jnorswor@uark.edu>
Subject: RE: formal request

Thanks Jason. I think this will be very helpful.

Related to Dr. Brown, do you know when you're expecting the data back or when you'd be able to share the air sampling analysis with EPA?

I really do appreciate everything you're doing.

REUBEN BARIS | PRODUCT MANAGER, TEAM 25 | HERBICIDE BRANCH

U.S. ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF PESTICIDE PROGRAMS | (703) 305-7356

From: Jason Keith Norsworthy [mailto:jnorswor@uark.edu]
Sent: Thursday, September 13, 2018 2:30 PM
To: Baris, Reuben <Baris.Reuben@epa.gov>
Subject: RE: formal request

Reuben,

Attached please find the assessments collected from the large-plot trial that I conducted in conjunction with Monsanto at Proctor, AR. Dr. Ashley Brown from MS State University is analyzing the air sample data collected from this trial. I have attached some slides that should help explain what was observed at this location. Let me know if you need anything else or have questions about the trial.

Regards,
Jason

Jason Norsworthy, PhD
Professor and Elms Farming Chair of Weed Science
1366 West Altheimer Dr.
Fayetteville, AR 72704
Tel: 479-575-8740
Mob: 479-313-1265

From: Baris, Reuben <Baris.Reuben@epa.gov>
Sent: Thursday, September 13, 2018 11:27 AM
To: Jason Keith Norsworthy <jnorswor@uark.edu>
Subject: formal request

Hey Jason,
This is the formal request, if you're willing, to share the data from your Proctor, AR study on the 240 acre, 80 acre block study.

Happy to discuss more by phone if necessary to talk about mechanisms for sharing with EPA.
Reuben

REUBEN BARIS | PRODUCT MANAGER, TEAM 25 | HERBICIDE BRANCH
U.S. ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF PESTICIDE PROGRAMS | (703) 305-7356

Message

From: Baris, Reuben [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=A0181E3F02A246FC915A4AF026E249FC-BARIS, REUBEN]
Sent: 9/13/2018 6:43:20 PM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
Subject: RE: formal request

Thanks Jason. I think this will be very helpful.

Related to Dr. Brown, do you know when you're expecting the data back or when you'd be able to share the air sampling analysis with EPA?

I really do appreciate everything you're doing.

REUBEN BARIS | PRODUCT MANAGER, TEAM 25 | HERBICIDE BRANCH
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Message

From: Baris, Reuben [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=A0181E3F02A246FC915A4AF026E249FC-BARIS, REUBEN]
Sent: 9/13/2018 2:09:21 PM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
Subject: PI's for various studies

Hey Jason,
Please review the list below and ensure I'm contacting the correct PI's for any data/study requests. Thanks. Reuben

Proctor, AR – The Honorable Dr. Jason Norsworthy
??, Indiana – Dr. Brian Young
??, Michigan –
??, Nebraska – Dr. Greg Kruger
??, Wisconsin –

Other studies/research:
Tennessee – Dr. Larry Steckel
Alabama -

Message

From: Baris, Reuben [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=A0181E3F02A246FC915A4AF026E249FC-BARIS, REUBEN]
Sent: 11/13/2018 8:21:14 PM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
Subject: 2,4-D - documents requested

Hi Jason,
Below are links to the documents you requested regarding 2,4-D/Enlist Duo

Link to the docket: https://www.regulations.gov/docket?D=EPA-HQ-OPP-2016-0594

Decision document: https://www.regulations.gov/document?D=EPA-HQ-OPP-2016-0594-0660

Ecological risk assessment: https://www.regulations.gov/document?D=EPA-HQ-OPP-2016-0594-0012

Drinking water exposure assessment: https://www.regulations.gov/document?D=EPA-HQ-OPP-2016-0594-0006

Human Health Risk Assessment: https://www.regulations.gov/document?D=EPA-HQ-OPP-2016-0594-0009

Occupation and Residential Exposure Assessment: https://www.regulations.gov/document?D=EPA-HQ-OPP-2016-0594-0011

Review of Benefits: https://www.regulations.gov/document?D=EPA-HQ-OPP-2016-0594-0010

REUBEN BARIS | ACTING CHIEF, RISK MANAGEMENT IMPLEMENTATION BRANCH II | PESTICIDE REEVALUATION DIVISION
U.S. ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF PESTICIDE PROGRAMS | (703) 305-7356

Message

From: Baris, Reuben [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=A0181E3F02A246FC915A4AF026E249FC-BARIS, REUBEN]
Sent: 9/11/2018 9:15:44 PM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
Subject: Re: Where is your 240 block study?

Thanks.

Sent from my iPhone

On Sep 11, 2018, at 4:57 PM, Jason Keith Norsworthy <jnorswor@uark.edu> wrote:

> Proctor, AR
>
> Sent from my iPhone
>
> On Sep 11, 2018, at 2:52 PM, Baris, Reuben <Baris.Reuben@epa.gov> wrote:
>
>> The one you took us to.
>>
>> AR or MO?
>>
>> Sent from my iPhone

Message

From: Baris, Reuben [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=A0181E3F02A246FC915A4AF026E249FC-BARIS, REUBEN]
Sent: 9/9/2018 3:22:11 AM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
Subject: Re: two apps in cotton

Thanks.

Sent from my iPhone

On Sep 8, 2018, at 11:21 PM, Jason Keith Norsworthy <jnorswor@uark.edu> wrote:

> Yes. They have glufosinate that can be sprayed on Xtend cotton for pigweed control.
>
> Sent from my iPhone
>
> On Sep 8, 2018, at 10:13 PM, Baris, Reuben <Baris.Reuben@epa.gov> wrote:
>
>> Hi Jason,
>> Could cotton growers live with one application in cotton?
>> Reuben
>>
>> REUBEN BARIS | PRODUCT MANAGER, TEAM 25 | HERBICIDE BRANCH
>> U.S. ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF PESTICIDE PROGRAMS | (703) 305-7356

Message

From: Baris, Reuben [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=A0181E3F02A246FC915A4AF026E249FC-BARIS, REUBEN]
Sent: 10/4/2018 5:49:56 PM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
Subject: RE: data

Thanks Jason. I really appreciate all your work, and effort to get this to us.

Best,
Reuben

REUBEN BARIS | PRODUCT MANAGER, TEAM 25 | HERBICIDE BRANCH
U.S. ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF PESTICIDE PROGRAMS | (703) 305-7356

From: Jason Keith Norsworthy [mailto:jnorswor@uark.edu]
Sent: Thursday, October 04, 2018 12:26 PM
To: Baris, Reuben <Baris.Reuben@epa.gov>
Subject: data

Reuben,

Attached are the files associated with the 2017 Monsanto trials comparing XtendiMax and Engenia along with my WSSA presentation. The trials were conducted in Arkansas, Missouri, Tennessee, Nebraska, and Indiana.

Let me know if you have questions. My administrative assistant will be sending you the Arkansas State Plant Board presentation that was given on September 20, 2018.

Regards,
Jason

Jason Norsworthy, PhD
Professor and Elms Farming Chair of Weed Science
1366 West Altheimer Dr.
Fayetteville, AR 72704
Tel: 479-575-8740
Mob: 479-313-1265

Message

From: Baris, Reuben [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=A0181E3F02A246FC915A4AF026E249FC-BARIS, REUBEN]
Sent: 9/9/2018 3:13:54 AM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
Subject: two apps in cotton

Hi Jason,
Could cotton growers live with one application in cotton?
Reuben

REUBEN BARIS | PRODUCT MANAGER, TEAM 25 | HERBICIDE BRANCH
U.S. ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF PESTICIDE PROGRAMS | (703) 305-7356

Message

From: Baris, Reuben [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=A0181E3F02A246FC915A4AF026E249FC-BARIS, REUBEN]
Sent: 9/18/2018 8:41:07 PM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
Subject: RE: Proctor data

Hi Jason,
The individuals we've been meeting with at Bayer, who are the same individuals that were previously associated with Monsanto, indicated to us that they have been unable to meet with you, and you have been unwilling to share the data you've generated from your study in Proctor, AR. I indicated that you had shared this data with the Agency but based on our conversations with you (the Principle Investigator) all requests to obtain data should be managed by the PI. It is not the practice of the EPA to share data generated by individuals or entities. We treat these data the same as any data generated and submitted by any registrant to support their own registrations, we are not permitted by our regulations to share that data with other registrants. We encouraged Bayer to contact you directly to obtain the raw data as we have contacted you for that purpose.

These data are extremely important to the EPA since it is one of the few studies done at a field scale under commercial application practices investigating off-target movement of XtendiMax. We are also in discussion with your colleagues in Indiana, Wisconsin, Nebraska, and Michigan.

Let me know if you would like to discuss further.

Thanks.
Reuben

REUBEN BARIS | PRODUCT MANAGER, TEAM 25 | HERBICIDE BRANCH
U.S. ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF PESTICIDE PROGRAMS | (703) 305-7356

From: Jason Keith Norsworthy [mailto:jnorswor@uark.edu]
Sent: Tuesday, September 18, 2018 12:48 PM
To: Baris, Reuben <Baris.Reuben@epa.gov>
Subject: Proctor data

Hi Rueben,

Can you please confirm Bayer's position on my XtendiMax data from Arkansas? I am interested to understand on what grounds they are dismissing the data when our first opportunity to share the results will not be until Wednesday at which time I will meet with Drs. John Chambers (formerly with Monsanto), Ty Witten (formerly with Monsanto), Bob Montgomery (formerly with Monsanto), and Ms. Arlene Cotie with Bayer CropScience.

I look forward to hearing from you.

Regards,
Jason

Jason Norsworthy, PhD
Professor and Elms Farming Chair of Weed Science
1366 West Altheimer Dr.
Fayetteville, AR 72704
Tel: 479-575-8740

Mob: 479-313-1265

Message

From: Baris, Reuben [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=A0181E3F02A246FC915A4AF026E249FC-BARIS, REUBEN]
Sent: 10/12/2018 11:40:05 PM
To: Sprague, Christy [sprague1@msu.edu]
CC: Greg Kruger [greg.kruger@unl.edu]; Young, Bryan G [BryanYoung@purdue.edu]; Peck, Charles [Peck.Charles@epa.gov]; Jason Keith Norsworthy [jnorswor@uark.edu]; Rodrigo Werle [rwerle@wisc.edu]; Reynolds, Dan [dreynolds@pss.msstate.edu]
Subject: Re: Large-scale dicamba studies: question RE: tank mixes

Thanks All. Hope you all have a nice weekend.
Reuben

Sent from my iPhone

On Oct 12, 2018, at 7:26 PM, Sprague, Christy <sprague1@msu.edu> wrote:

MSU also did the same as Bryan and Greg.

Sincerely,
Christy

From: Greg Kruger <greg.kruger@unl.edu>
Sent: Friday, October 12, 2018 6:17 PM
To: Young, Bryan G <BryanYoung@purdue.edu>
Cc: Baris, Reuben <Baris.Reuben@epa.gov>; Peck, Charles <Peck.Charles@epa.gov>; Jason Keith Norsworthy <jnorswor@uark.edu>; Rodrigo Werle <rwerle@wisc.edu>; Sprague, Christy <sprague1@msu.edu>; Reynolds, Dan <dreynolds@pss.msstate.edu>
Subject: Re: Large-scale dicamba studies: question RE: tank mixes

My answers are the same as Bryan's.

Greg

Sent from my iPhone

On Oct 11, 2018, at 2:15 PM, Young, Bryan G <BryanYoung@purdue.edu> wrote:

Reuben,

Answer #1 - One tankmix at 15 GPA with the following products:
Xtendimax @ 22 oz/A
Roundup PowerMax @ 32 oz/A
Intact DRA @ 0.5% v/v

Answer #2 – No deviations from the protocol shared by Monsanto were implemented.

Best,
Bryan

Bryan Young
Professor of Weed Science

Department of Botany and Plant Pathology
Purdue University
1351 Lilly Hall of Life Sciences
915 West State Street
W. Lafayette, IN 47907
Email: BryanYoung@Purdue.edu
Voice: 765.496.1646

From: Baris, Reuben <Baris.Reuben@epa.gov>
Sent: Thursday, October 11, 2018 2:08 PM
To: Rodrigo Werle <rwerle@wisc.edu>; Young, Bryan G <BryanYoung@purdue.edu>; Greg Kruger <greg.kruger@unl.edu>; sprague1@msu.edu; Reynolds, Dan <dreynolds@pss.msstate.edu>
Cc: Peck, Charles <Peck.Charles@epa.gov>; Jason Keith Norsworthy <jnorswor@uark.edu>
Subject: Large-scale dicamba studies: question RE: tank mixes

Drs. Werle, Young, Kruger, Sprague, Reynolds and Norsworthy:

I hope these are easy questions for you all. If you don't want to cc the whole group on this email, you can respond directly to me.

1) What were the tank mix(es) you used in your study for xtendimax off-target movement?
- specifically, was acetochlor (e.g., warrant or other product) used?

2) Were there were any (notable) deviations that they made to the protocol when conducting the study

Thanks for your quick reply.
Reuben

REUBEN BARIS | PRODUCT MANAGER, TEAM 25 | HERBICIDE BRANCH
U.S. ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF PESTICIDE PROGRAMS | (703) 305-7356

Message

From: Baris, Reuben [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=A0181E3F02A246FC915A4AF026E249FC-BARIS, REUBEN]
Sent: 1/28/2018 5:42:36 PM
To: Greg Kruger [greg.kruger@unl.edu]; Barrett, Michael [mbarrett@uky.edu]; Jill Schroeder [jill.schroeder@ars.usda.gov]
CC: tmueller@tennessee.edu; Bradleyke@missouri.edu; Reynolds, Dan [dreynolds@pss.msstate.edu]; ALFRED Culpepper [stanley@uga.edu]; Bryan Young (BryanYoung@purdue.edu) [BryanYoung@purdue.edu]; Jason Keith Norsworthy [jnorswor@uark.edu]; Steckel, Larry [lsteckel@utk.edu]; Aaron Hager [hager@illinois.edu]; Zollinger, Richard [r.zollinger@ndsu.edu]; mdowen@iastate.edu; Senseman, Scott [ssensema@utk.edu]; 'David Shaw' [dshaw@research.msstate.edu]; Scott Bretthauer [SBretthauer@agaviation.org]
Subject: RE: Meeting at EPA

Hello All,
I wanted to send out a quick thanks to Greg for helping to organize this meeting. And thank you all for taking the time out of your busy schedules here in DC during the WSSA conference to come to the Office of Pesticide Programs and meet with us. I am excited to hear about the research you all have been conducting and I think we will have a good group from the Office of Pesticide Programs listening to what you have to share related to off-target movement of dicamba.

I want to take a quick moment to dispel any rumors that may be spreading about this meeting. There will be no recording, no open teleconference line. This is not a secret meeting, but what is said in this meeting will stay in the room. Greg and I wanted to hold this meeting with the intent to provide a forum for you all to share some of the research you are conducting with the Agency in an informal format. That being said, I must stress that the Agency is listening and this will not be a policy setting meeting. We have rules and regulations about setting policy behind closed doors...the Federal Advisory Committee Act (FACA) is a Federal law that governs the establishment and operation of advisory committees. This is a non-FACA meeting. However, through all of the noise and distractions with dicamba we are keen to use the best available data that is relevant to inform any decision making.

If you have any questions, or want to reach out to me directly, you have my email. Or call me directly at 703-305-7356.

I look forward to meeting you all tomorrow. For those of you that are not able to attend, I hope to meet you during the conference.
Thank you.
Reuben

REUBEN BARIS | HERBICIDE BRANCH | REGISTRATION DIVISION
U.S. ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF PESTICIDE PROGRAMS | (703) 305-7356

-----Original Message-----
From: Greg Kruger [mailto:greg.kruger@unl.edu]
Sent: Sunday, January 28, 2018 9:21 AM
To: Baris, Reuben <Baris.Reuben@epa.gov>; Barrett, Michael <mbarrett@uky.edu>; Jill Schroeder <jill.schroeder@ars.usda.gov>
Cc: tmueller@tennessee.edu; Bradleyke@missouri.edu; Reynolds, Dan <dreynolds@pss.msstate.edu>; ALFRED Culpepper <stanley@uga.edu>; Bryan Young (BryanYoung@purdue.edu) <BryanYoung@purdue.edu>; Jason Keith Norsworthy <jnorswor@uark.edu>; Steckel, Larry <lsteckel@utk.edu>; Aaron Hager <hager@illinois.edu>; Zollinger, Richard <r.zollinger@ndsu.edu>; mdowen@iastate.edu; Senseman, Scott <ssensema@utk.edu>; 'David Shaw' <dshaw@research.msstate.edu>; Scott Bretthauer <SBretthauer@agaviation.org>
Subject: RE: Meeting at EPA

All,

This is a last minute reminder that tomorrow we will be meeting with EPA.

I know some of you have told me that you cannot make the meeting, but I am keeping you in the loop just in case something has changed. I would like to assemble everybody that has interest in going and can make the meeting in the lobby of the Marriott at 12:45. Once assembled, we will walk over to the EPA headquarters. Google maps shows says it is a 16 minute (0.9 mile walk). I will have a taxi arranged to take anybody who doesn't want to walk come pick you up. If you are not interested in walking and haven't already told me so, please let me know as soon as possible so that I know if I need more than one car. The meeting will start at 1:30, but it will take a little time to get everybody through security once we get to the building. Reuben will be there to help us get through. For those that haven't been there, if you are bringing a computer, please be prepared to pull it out and registered it once we get there. Getting into the building will be very similar to your experiences with TSA.

I want to thank you all for taking time to share your research and field experiences. I know this will be very valuable for EPA.

Best wishes,

Greg

-----Original Message-----
From: Greg Kruger
Sent: Wednesday, January 3, 2018 4:24 PM
To: Baris, Reuben <Baris.Reuben@epa.gov>; Barrett, Michael <mbarrett@uky.edu>; Jill Schroeder <jill.schroeder@ars.usda.gov>
Cc: tmueller@tennessee.edu; Bradleyke@missouri.edu; Reynolds, Dan <dreynolds@pss.msstate.edu>; ALFRED Culpepper <stanley@uga.edu>; Bryan Young (BryanYoung@purdue.edu) <BryanYoung@purdue.edu>; Jason Keith Norsworthy <jnorswor@uark.edu>; Steckel, Larry <lsteckel@utk.edu>; Aaron Hager <hager@illinois.edu>; Zollinger, Richard <r.zollinger@ndsu.edu>; mdowen@iastate.edu; Senseman, Scott <ssensema@utk.edu>
Subject: RE: Meeting at EPA

All,

I hope 2017 turned out well for you and 2018 is off and running! Since WSSA is just around the corner and since it is Crystal City this year, we want to take full advantage of the proximity to EPA. I have been working with Reuben Baris at EPA to set up a meeting to discuss off-target movement of dicamba. We know that there is never going to be a convenient time for everybody, but we have settled on trying to do the meeting on Monday January 29th at 1:30 pm. We will keep the meeting short (1 hour) at EPA headquarters. This means that we will have about a 15 minute walk from the hotel or I can see if we can get a shuttle arranged if enough people are interested in going that route. I would like to get the group walking towards EPA headquarters at 12:45 because it will take a little time to get through security once we get there. The main purpose of the meeting will be to give you guys a chance to share with EPA what questions you are asking (of the growers and of industry), what you are working on, and what you are finding related to off-target movement of dicamba. It is our hope that it will then lead into a discussion on what are the implications for 2018. If you are both willing and able to make the meeting, please let me know by next Wednesday so that I can have a head count.

Thanks,

Greg

Message

From: Baris, Reuben [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=A0181E3F02A246FC915A4AF026E249FC-BARIS, REUBEN]
Sent: 8/17/2018 5:43:42 PM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
Subject: Re: Reference for Dicamba Thesis

Thank you. I think our folks in EFED will need it if they end up using it.

Sent from my iPhone

On Aug 17, 2018, at 1:30 PM, Jason Keith Norsworthy <jnorswor@uark.edu> wrote:

Reuben,

I just called the student. He has graduated, but said he could resend me the data on tomorrow or Sunday. I will send you the JMP files and possibly Excel files when he sends them.

Regards,
Jason

Jason Norsworthy, PhD
Professor and Elms Farming Chair of Weed Science
1366 West Altheimer Dr.
Fayetteville, AR 72704
Tel: 479-575-8740
Mob: 479-313-1265

From: Baris, Reuben <Baris.Reuben@epa.gov>
Sent: Friday, August 17, 2018 11:38 AM
To: Jason Keith Norsworthy <jnorswor@uark.edu>
Subject: Fwd: Reference for Dicamba Thesis

Hey Jason,

Is it possible for you to share the raw data from your student's thesis?
Thanks
Reuben

Message

From: Baris, Reuben [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=A0181E3F02A246FC915A4AF026E249FC-BARIS, REUBEN]
Sent: 8/17/2018 4:37:33 PM
To: jnorswor@uark.edu
Subject: Fwd: Reference for Dicamba Thesis
Attachments: Evaluation of Dicamba Off-Target Movement and Subsequent Effects on Soybean Offspring.pdf; ATT00001.htm

Hey Jason,

Is it possible for you to share the raw data from your student's thesis?
Thanks
Reuben

5-2018

Evaluation of Dicamba Off-Target Movement and Subsequent Effects on Soybean Offspring

Gordon Travis Jones
University of Arkansas, Fayetteville

ED_002296_00002594-00001

Evaluation of Dicamba Off-Target Movement and Subsequent Effects on Soybean Offspring

A thesis submitted for partial fulfillment
of the requirements for the degree of
Master of Science in Crop, Soil, and Environmental Sciences

by

G. Travis Jones
Southeast Missouri State University
Bachelor of Science, Wildlife and Conservation Biology, 2006
Bachelor of Science, Plant and Soil Science, 2009

May 2018
University of Arkansas

This thesis is approved for recommendation to the Graduate Council.

Dr. Jason Norsworthy
Thesis Director

Dr. Tom Barber
Committee Member

Dr. Larry Purcell
Committee Member

Dr. Bob Scott
Committee Member

Dr. Edward Gbur
Committee Member

Dr. Trent Roberts
Committee Member

ABSTRACT

Commercial launch of cotton with resistance to dicamba, glyphosate, and glufosinate occurred in 2015 and launch of soybean with resistance to dicamba and glyphosate occurred in early 2016. It is likely that non-dicamba-resistant soybean will be planted in close proximity to dicamba-resistant soybean and cotton. Therefore, experiments were conducted to examine the distance dicamba moves during an application using commercial application equipment, as well as the effect the drift events have upon soybean offspring. Additional experiments were designed to investigate the effect glyphosate addition to dicamba has upon soybean growth and yield as well as possible effects on offspring. Lastly, an experiment was designed to determine the extent of secondary (volatile) drift of two formulations of dicamba under mid-summer conditions. Drift of dicamba exceeded 150 m in some drift trials (5% soybean injury). Drift trials established at early reproductive stages were more damaging to parent soybean; however, applications to late reproductive soybean were more detrimental to the soybean offspring. Percent of parent pods malformed resulting from dicamba drift events at the R5 growth stage displayed the highest correlation coefficients with offspring emergence ($r = -0.37$, $p = 0.0082$), vigor ($r = -0.57$, $p = < 0.0001$), injury ($r = 0.93$, $p = < 0.0001$), and amount of plants injured ($r = 0.92$, $p = < 0.0001$). When low rates of glyphosate were added to low rates of dicamba and applied to soybean at R1 growth stage, leaf malformation at 28 days after application (DAA) was increased over low rates of dicamba alone. Dicamba also caused damaging effects to soybean offspring; however, the addition of glyphosate did not increase further impact on soybean offspring. Diglycolamine (DGA) and N,N-Bis-(aminopropyl) methylamine (BAPMA) forms of dicamba are suspected to be similar in terms of primary drift; however, injury caused by secondary drift from BAPMA dicamba was less than DGA dicamba at 21 days after application (DAA). These results

document that caution should be used to minimize the risk for damage to neighboring non-dicamba-resistant soybean fields.

ACKNOWLEDGMENTS

The author would like to thank the Arkansas Soybean Promotion Board and BASF for funding and supporting this research.

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Chapter 4

General Introduction

Dicamba-resistant (DR) cotton (*Gossypium hirsutum* L.) and soybean (*Glycine max* L.) have been deregulated and were commercially launched in 2015 and 2016, respectively. However, approval by the Environmental Protection Agency (EPA) of a dicamba-containing herbicide for over-the-top applications to these crops was not given until November 9, 2016. Therefore, growers in some states were able to incorporate dicamba in the form of Xtendimax (Monsanto Corporation, St. Louis, MO 63167) or Engenia (BASF Corporation, Research Triangle Park, NC 27709) into dicamba-resistant (DR) crops in 2017.

Dicamba is a synthetic auxin herbicide in the benzoic acid family. Currently only six weeds have evolved resistance to dicamba worldwide (Heap 2017). However, only two incidences have occurred in the U.S. Kochia (*Kochia scoparia* L. Schrad.) has acquired resistance in populations in Kansas, Nebraska, Montana, North Dakota, Idaho, and Colorado. Populations in Idaho of prickly lettuce (*Latuca serriola* L. Lacse) have also conferred resistance to dicamba. The lack of evolved resistance may be good news to growers; however, history has demonstrated that increased herbicide reliance often quickly leads to resistance (Culpepper et al. 2006; Harker et al. 2017).

Much of the dicamba labeled for use before supplemental registration for DR cotton and soybean was applied in early spring as a preplant burndown application or in early vegetative applications to corn (*Zea mays* L.) or grain sorghum (*Sorghum bicolor* L. Moench.) prior to most soybean emergence (Anonymous 2014). Now that dicamba is labeled for in-crop use for DR cultivars, applications will be made much later in the growing season than current use patterns as applications will be allowed to soybean through R1 growth stage (Anonymous 2016a;

Anonymous 2016b). Therefore, the likelihood of applications being made when non-DR soybean have emerged in the nearby vicinity is great.

Approximately 50% of the agronomic crop hectares in Arkansas is annually planted to soybean (USDA 2016). Most growers may not want to plant a single variety, but rather choose to guard against economic loss by planting multiple varieties. Consequently, those choosing to plant DR soybean along with non-DR soybean will need to be aware of proper dicamba cleanout techniques to guard against damaging non-DR soybean in subsequent applications. Researchers have suggested that a single cleanout of spray tanks with an ammonia solution is not adequate to eliminate dicamba residue. Yet, two flushes with ammonia proved to be sufficient in removal of dicamba residue (Boerboom 2004). A triple-rinse procedure is commonly recommended to guard against sprayer contamination and subsequent exposure to a susceptible crop.

Exposure to non-DR soybean from primary (physical) drift of dicamba will not be reduced by new formulations. Applicators will need to be wary of environmental conditions during and soon after application of dicamba-containing products. Wind speeds have a near linear relationship with spray particle drift from ground applications (Maybank et al. 1978) and temperature inversions may result in off-target movement due to the inability of spray particles to settle to the soil surface. Furthermore, the type of spray equipment and how it is used will influence the risk for off-target movement via primary drift. Improper nozzle selection, application speed, and boom height can vastly increase the amount of primary spray drift that occurs (Maybank et al. 1978; Wolf et al. 1992).

Even after spray particles reach their intended site, subsequent volatilization may occur. Relative humidity and temperature are the primary factors affecting volatility (Egan and Mortenson 2012; Mueller et al. 2013). Increased temperature likewise causes greater risk for volatilization of dicamba. Furthermore, when low humidity accompanies high temperatures, risk for volatility further increases because there is greater available space in the atmosphere for dicamba to volatilize (Mueller et al. 2013). Volatilization of dicamba is possible from time of spraying up to three days after application, albeit most volatilization occurs in the first 12 hours after application (Behrens and Lueschen 1979; Mueller et al. 2013, Egan and Mortenson 2012). Nevertheless, studies have documented that as little as 1 mm of simulated rainfall will eliminate subsequent volatility (Behrens and Lueschen 1979).

Dicamba formulations have been known to differ in terms of likelihood and amount of volatility (Behrens and Lueschen 1979; Egan and Mortenson 2012; Mueller et al. 2013). The diglycolamine (DGA) salt of dicamba has been documented to have reduced secondary loss by 94% when compared to the dimethylamine (DMA) form of dicamba (Egan and Mortenson 2012). In other research, the sodium salt of dicamba was also found less volatile than the DMA form of dicamba (Behrens and Lueschen 1979).

If primary drift, secondary drift, or tank contamination occur, non-DR soybean will likely show symptoms within the first day to week after the event, depending on the dose incurred and rate of vegetative growth. Symptomology is commonly seen as chlorosis of terminal buds, cupping or crinkling of canopy leaves, swollen petiole bases, and leaf or stem epinasty (Auch and Arnold 1978; Sciumbato et al. 2004; Wax et al. 1969; Wiedenhamer et al. 1989). When soybean is exposed to higher drift rates of dicamba, stem cracking, terminal death, or plant termination may result (Griffin et al. 2013; Robinson et al. 2013; Solomon and Bradley 2014; Thompson and Egli 1973).

Growth stage at the time of the drift or contamination event will also play a role in injury to soybean. Dicamba exposure to soybean during vegetative stages does not always result in yield reduction (Al-Khatib and Peterson 1999; Andersen et al. 2004; Auch and Arnold 1978; Johnson et al. 2012; Kelley et al. 2005; Wax et al. 1969). However, early flowering stages are the most sensitive to yield reduction for non-DR soybean (Auch and Arnold 1978; Solomon and Bradley 2014; Wax et al. 1969).). Height reduction was also documented to accompany yield loss; yet, height reduction is not always an indicator of yield loss (Auch and Arnold 1978; Weidenhamer et al. 1989).

It is most likely that dicamba will be applied as a mixture or commercial premix with glyphosate in DR cotton and soybean to achieve broad-spectrum weed control. The addition of a full rate of glyphosate to low rates of dicamba can increase injury over the low rate of dicamba alone, when applied to glyphosate-resistant (GR) soybean (Kelley et al. 2005). Other research has documented an increase in control of glyphosate-resistant weeds by dicamba and glyphosate combinations over dicamba alone (Spaunhorst and Bradley 2013). As glufosinate-resistant soybean and conventional soybean acreage in Arkansas continues to increase in recent years, there may be increased risk for off-target movement and injury to soybean when dicamba is mixed with glyphosate over that of dicamba alone.

Information in the literature on the effect of dicamba on resulting offspring is limited; yet, deleterious effects of dicamba on offspring have been documented. Dicamba applied at 220 or 560 g ae ha^{-1} during flowering and podfill did not allow production of viable seed. Offspring from plants treated with dicamba at 11 to 56 g ha^{-1} at flowering and podfill reduced emergence from that of the nontreated check (Auch and Arnold 1978; Thompson and Egli 1973). Reductions in vigor were noticed in offspring from parents treated with dicamba at 30 g ha^{-1} (Thompson and Egli 1973). All seedling offspring displayed dicamba-like injury symptoms by the first trifoliate stage, with the most severe symptoms occurring for podfill applications. This is likely because the filling pod served as a strong sink for dicamba, which is mobile in the phloem of the plant (Senseman 2007). In addition, dicamba applied at flowering would have more time to be metabolized before podfill begins. Dicamba-like symptoms on offspring were transient and no injury was observed by the V2 stage of the offspring (Thompson and Egli 1973). There is no research in the literature pertaining to the effect of dicamba plus glyphosate combinations on soybean offspring; however, no negative effects to offspring were observed when glyphosate was applied from 8 to 420 g ae ha^{-1} at vegetative and reproductive stages (Norsworthy 2004).

Dicamba will be a useful tool for aiding in control of many glyphosate-resistant weeds and others that are difficult to control in current soybean production systems; however, precautions must be taken to reduce the possibility of off-target movement. New forms of dicamba may display a lower likelihood of volatility when compared to some previous forms, but off-target movement could still occur with poor stewardship, misapplication, or less than ideal environmental conditions at the time of application. In most cases, injury resulting from low rates of dicamba at vegetative stages should not reduce yield if terminal growth is not suspended (Auch and Arnold 1978; Weidenhamer et al. 1989). However, dicamba drift events during soybean reproductive development will likely cause greater risks for yield loss, and effects may be seen on the offspring in the form of reduced emergence and vigor (Thompson and Egli 1973). Further research is needed to understand the risks for off-target movement of dicamba, which should aid in establishing buffers to nearby sensitive crops. Effects of an actual drift event on soybean offspring are unknown; hence, they need to be investigated. Additionally, research quantifying possible differences in secondary drift of the DGA and BAPMA forms of dicamba is crucial before products are to be accepted for registration. Therefore, our objectives were: (1) to quantify the distance of off-target movement of the DGA form of dicamba to non-

DR soybean when applied using sprayer setup recommendations designed to minimize physical drift (Anonymous 2013), (2) to establish the relationship between direct damage to soybean plants with the appearance of dicamba-like symptomology or damage to soybean offspring following an actual drift event on the parent plants, (3) to assess damage to non-DR and non-glyphosate-resistant soybean when low rates of dicamba and glyphosate are applied during reproductive development as a mixture versus applying the herbicides alone, and (4) to determine the amount secondary drift occurring from two dicamba formulations under conditions that are likely during mid-summer applications in the Midsouth.

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Chapter 1

Off-Target Movement of Diglycolamine Dicamba to Non-Dicamba Soybean Using Practices to Minimize Primary Drift

Abstract

Soybean with resistance to dicamba (DR soybean) and glyphosate as well as cotton with resistance to glyphosate, glufosinate, and dicamba were recently commercialized in the US and have been readily adopted. To evaluate possible results of over-the-top application of dicamba in DR crops, field studies were designed to examine off-target movement using proposed sprayer setup recommendations. Association analysis and non-linear regression techniques were used to examine the effects of 26 field-scale drift trials conducted in 2014 and 2015 during soybean reproductive development (R1 through R6). The greatest predictors (injury, height reduction) of soybean yield reduction generally occurred and had steeper relationships after drift events at R1 growth stage than at later stages. Using non-DR soybean as an indicator, dicamba was documented to move as much as 152 m from the application area (distance to 5% injury). Instances of height reduction (5%) differed among growth stages with the greatest distance occurring at R1 (83.4 m). Soybean yield reduction was erratic with the greatest distance to 5% loss in yield occurring at 90.4 m after an R2 drift event. Overall, flowering stage soybean seems to be more sensitive than later reproductive soybean to injury, height reductions, and yield loss. Average and maximum wind speeds did not account for the injury documented, and it is hypothesized that other meteorological variables also play a notable role in dicamba off-target movement. With concerns of off-target movement of dicamba being on the forefront, proper stewardship of this new technology will be key to its longevity.

Nomenclature: dicamba; cotton, *Gossypium hirsutum* L.; soybean, *Glycine max* (L.) Merr.

Key words: Off-target movement, auxin-like symptomology, leaf malformation, pod malformation, soybean growth stages, dicamba volatility

Introduction

With resistance becoming more of a problem in broadleaf weeds such as Palmer amaranth (*Amaranthus palmeri* S. Wats.), waterhemp (*Amaranthus* spp.), and horseweed (*Conyza canadensis* L. Cronq.), there is a need for new herbicides to provide a different approach to control these broadleaf weeds in soybean and cotton (Kruger et al. 2010; Meyer et al. 2015). Research has documented that dicamba will effectively control these problem weeds and others when used properly in DR cotton and soybean (Byker et al. 2013; Cahoon et al. 2015). However, off-target movement to susceptible crops is of concern.

Off-target movement of pesticides can be complex in that spraying equipment, wind speed, crop stage, crop sensitivity, atmospheric conditions, and properties of the spray solution may all interact to influence the extent of a drift event (Heidary et al. 2014; Lofstrom et al. 2013). Many regulations have been put in place pertaining to these variables for dicamba application in DR soybean and cotton to limit off-target movement of the herbicide (Anonymous 2017a; Anonymous 2017b). However, lack of applicator training could still result in misapplications (Bish and Bradley 2017).

Off-target movement may occur as primary or secondary movement. Primary movement occurs at the time of application with the physical movement of spray droplets or evaporated particles from the target to an off-target site where a susceptible species may be growing. Influences on primary drift include droplet spectrum, wind speed, boom height, temperature, relative humidity, and spray pressure (Bueno et al. 2017; Maybank et al. 1974; Maybank et al. 1978; Threadgill and Smith 1975).

All herbicides have the potential for primary off-target movement; however, a select few also are subject to volatilization after application occurs. Previous dicamba products, such as the dimethylamine (DMA) salt formulation, have been known to readily cause volatile injury to nearby soybean (Behrens and Lueschen 1979). Increased temperature from 20 to 30 C is documented to double soybean response from volatility of the DMA salt of dicamba within closed chambers. Furthermore, reduced humidity was shown to also increase volatility in closed chamber experiments (Behrens and Lueschen 1979).

Recently, new lower volatile formulations of dicamba have been labeled for use in DR-crops (Anonymous 2017c; Anonymous 2017d). Xtendimax with VaporGrip (Monsanto Company, St. Louis, MO) is a combination of the previously available diglycolamine (DGA) form of dicamba and an additive that is claimed to reduce volatile losses by inhibition of free dicamba acid formation (MacInnes 2017). Additionally, the N,N-Bis-(aminopropyl) methylamine (BAPMA) form of dicamba (Engenia, BASF Corporation, Research Triangle Park, NC) was granted supplemental registration soon after. This form of dicamba is also purported to have reduced volatility over previous forms (Westberg and Adams 2017).

When supplemental labeling of Xtendimax with VaporGrip and Engenia occurred, only one nozzle was listed for use in DR soybean and cotton. Currently, 26 nozzles are approved for use in the application of Xtendimax with VaporGrip (Anonymous 2017a), whereas only 13 nozzles are allowed for use with Engenia (Anonymous 2017b). Nozzle selection is very important in achieving the desired droplet size to limit primary off-target movement (Heidary et al. 2014). Herbicides added to dicamba may also influence droplet size of the spray solution as the addition of *S*-metolachlor to Engenia was documented to reduce median droplet size by 28% when Turbo Teejet Air Inducted (TTI) nozzles were used (Meyer et al. 2016).

An ecological risk assessment for dicamba under the Endangered Species Act, using soybean as a bioindicator of risk based solely on plant height and weight reduction but not the presence of symptoms or yield loss, was completed by the Environmental Protection Agency (EPA) before approval of the herbicide for use in DR soybean and cotton (Anonymous 2017e; Environmental Protection Agency 2016). Subsequently, the Xtendimax with VaporGrip and Engenia labels both require a 33.3 m downwind application buffer to the field edge if vegetation exists such as a lawn or treeline due to the Endangered Species Act (Anonymous 2017c; 2017d). Hence, this buffer must be present from the last row treated to any non-crop vegetated area. However, buffers are not applicable when DR cotton or soybean are bordered by at least 33.3 m of DR cotton or soybean, corn (*Zea mays* L.), sorghum (*Sorghum bicolor* (L.) Moench), proso millet (*Panicum miliaceum* L.), small grains, sugarcane (*Saccharum officinale* L.), fields prepared for planting, areas covered by the footprint of a manmade structure with walls and roof, roads, paved surfaces, or graveled surfaces. Yet, under the language of the label, non-DR soybean may exist downwind of applications made to DR cotton and soybean if 33.3 m of the above-mentioned crops or structures are established in between. Though legal, the decision to spray in these circumstances is up to the applicator's discretion and is entirely their responsibility if damage to susceptible crops occur.

Soybean is highly sensitive to dicamba and may show visual injury such as leaf cupping at very low rate exposure (Auch and Arnold 1978; Weidenhamer et al. 1989). However, visual injury to soybean from dicamba does not always translate into yield reduction (Al-Khatib and Peterson 1999; Barber et al. 2017; Kelley et al. 2005; Solomon and Bradley 2014; Soltani et al. 2016; Weidenhamer et al. 1989; Westberg et al. 2016). Although some research has documented yield reduction to be similar among growth stages (Foster and Griffin 2016; Kelley et al. 2005; Weidenhamer et al. 1989) others have documented the early flowering stages (R1-R2) to be most yield limiting when compared to vegetative stages (Griffin et al. 2013; Robinson et al. 2013;

Soltani et al. 2016; Solomon and Bradley 2014). Conditions such as drought and high temperatures around the time of exposure to dicamba have been shown to influence soybean yield (Al-Khatib and Peterson 1999; Anderson et al 2004; Auch and Arnold 1978; Kelley et al. 2005; Weidenhamer et al. 1989). Soybean growth habit has also been cited to influence response to low rates of dicamba (Auch and Arnold 1978; McCown et al. 2016a; Wax et al. 1969; Weidenhamer et al. 1989). Therefore, the variability in yield loss among growth stages could possibly be due to environmental conditions or growth habit of soybean used in the conflicting studies.

Research studies have been conducted concerning herbicide drift from ground applications (Bueno et al. 2017; Heidary et al. 2014; Lofstrom et al. 2013). However, these studies were conducted at close range and attempted to quantify drift by using materials to catch particles to later be analyzed by laboratory equipment. Furthermore, the use of materials to catch drifting particles may underestimate or be unable to quantify the amount of dicamba reaching further distances because it may evaporate or volatize prior to settling. Because of the high sensitivity of soybean to dicamba, the crop is an excellent bioindicator to measure off-target movement. The objectives of this research were to: 1) identify the distance moved by a foliar application of the DGA salt of dicamba to reproductive soybean from a high-clearance sprayer using soybean injury, height, and yield as a bioindicators, 2) evaluate the correlations between soybean injury, height, pod malformation, and yield when exposed to a DGA dicamba drift event, and 3) determine the relationship between soybean response variables and the distance from the area where DGA dicamba was applied.

Materials and Methods

Twenty-five field experiments were conducted in 2014 and 2015 at the Northeast Research and Extension Center in Keiser, Arkansas, to examine off-target movement of DGA dicamba using a sprayer setup that was anticipated as requirements for applying new formulations of dicamba in DR soybean and cotton (Anonymous 2013; Anonymous 2014). One additional experiment was conducted at the Lon Mann Cotton Research Station (LMCRS) near Marianna, Arkansas, in 2015. All drift experiments were conducted using the commercially available DGA formulation of dicamba branded Clarity® (BASF Corporation, Raleigh, NC). Timing for dicamba applications was restricted to the reproductive stages of R1 through R6. Dicamba was applied at 560 g ae ha^{-1} using a Bowman Mudmaster Sprayer (Bowman Manufacturing, Newport, AR 72112) traveling 16 km h^{-1}. The high-clearance sprayer was equipped with TeeJet AIXR 11003 nozzles (TeeJet Technologies, Wheaton, IL 60187) and calibrated to deliver 93.5 L ha^{-1} at 275 kPa to achieve a very-coarse droplet spectrum. It is acknowledged that the current nozzles recommended for the new formulations of dicamba do not include AIXR 11003 nozzles. Rather, the current labels permit use of certain nozzles that produce either an extremely-coarse or ultra-course droplet spectrum. However, at the beginning of this study it was publicized that very-coarse spray spectrums, along with outputs of 93.5 L ha^{-1} would be allowed for dicamba application (Anonymous 2013; Anonymous 2014).

The application area was 8 by 30 m in size where the wind blew parallel or less than 45 degrees to the soybean rows (Figure 1A) and 8 by 60 m in size where the wind blew perpendicular or greater than 45 degrees to the soybean rows (Figure 1B). Handheld Kestrel anemometers (Nielson-Kellerman CO, Birmingham, MI) were used to record wind speed every second during applications. Angle of wind direction, temperature, and relative humidity were also recorded at the time of application. At 28 days after application (DAA) in experiments where the wind was greater than 45 degrees from the soybean rows, three transects were established across rows extending downwind from the area sprayed (Figure 1B). The centers of transects were initiated at 18, 30, and 42 m into the 60-m application swath. Each plot was four rows, spaced 96 cm and 12 m in length, with only the center two being used for data collection. Plots extended along transects until no injury was observed or the end of the field was reached. In experiments where the wind was less than 45 degrees from the soybean rows, transects were laid out extending downwind from the center and to the left and right side of the downwind edge of the 8- by 30-m application area in four-row increments until no injury was observed laterally. Plots were established down rows in 6-m lengths until no injury was observed. Again, rows were spaced 96 cm, and data were collected from the center two of four rows. Grid coordinates were given to each plot with x=0 and y=0 being the center of the downwind edge of the application.

Soybean injury and three canopy heights were recorded at 28 DAA for each plot. A visual scale from 0 to 100%, with 100% being plant death, was used to estimate soybean injury. The percent of pods malformed and the height to the terminal of three individual plants per plot were recorded at soybean maturity. Both canopy height and mature height were converted to a percent relative to uninjured plots by selecting three random plots having 0% soybean injury (outside of the drift plume) at 28 DAA. Percentage of pods malformed were recorded on a 0 to 100% scale, with 0 being no pod malformation and 100 being all pods having malformation. A small-plot combine was used to harvest plots, and grain yields were corrected to 13% moisture before being converted to a percentage yield relative to uninjured plots.

Correlation analysis was conducted using JMP Pro 12 (SAS Institute, Cary, NC) and Pearson pairwise correlations were produced between injury at 28 DAA, relative canopy height at 28 DAA, percentage of mature pods malformed, relative terminal height at maturity, and relative yield. Contour maps were constructed using SAS 9.4 (SAS Institute, Cary, NC) for each drift trial illustrating 28 DAA injury, percent of pods malformed at maturity, mature relative terminal height, and relative yield. Regression analysis was performed using a single line of data closest to the center of the drift plume as determined by the contour maps in conjunction with injury ratings and exact distance to the center of each plot from the center of the edge of the application area. Essentially, the plot reported to have the highest amount of injury at 28 DAA in each transect was closest to the center of the drift plume. These same plots were used in the regressions for 28 DAA relative canopy height, mature percent of pods malformed, mature relative terminal height, and relative yield. Because the location of each plot was represented by an x and y value, exact distance to the center of each plot was computed using the Pythagorean Theorem. These data were used to construct models to determine the distance to 5% injury at 28 DAA, 5% canopy height reduction at 28 DAA, 5% terminal height reduction at maturity, mature pod malformation of 5%, and 5% yield loss for each drift event. The regression models were tested using Sigma Plot (Systat Software Inc., San Jose, CA) regarding significance ($\alpha = 0.05$) and goodness of fit (r^2, AIC, BIC). Exponential models have been used previously to describe spray deposition as a function of distance from a drift event (Bueno et al. 2017). Therefore, one, two, three, and four parameter models were tested to decide the best fit. Measures of AIC and BIC were used to compare across models with the lowest values indicating the best fit. Regression figures were assembled using JMP 13 Pro (SAS Institute, Cary, NC).

Results and Discussion

Correlation analysis between soybean injury, height, pod malformation, and yield. Generally, relationships between parameters evaluated were stronger following drift events at flowering stages (R1 to R2) than at pod (R3 to R4) or seed-forming stages (R5 to R6) (Tables 1, 2; Figures 2 through 7). Correlations between observations were greatest when the drift events occurred at R1 growth stage likely because the opportunity for growth prior to maturity is greater at R1 growth stage (Table 1). Previous research has also documented the flowering stages to be most sensitive to yield loss compared to vegetative or later reproductive stages (Auch and Arnold 1978; Griffin et al. 2013; Robinson et al. 2013; Solomon and Bradley 2014; Wax et al. 1969).

Soybean injury associated with R1 and R2 drift events was often two-fold the injury seen in later drift events (Figures 2 and 3). When soybean is exposed to dicamba, the effects are only seen in new growth because dicamba translocates to newly formed meristematic tissue (Senseman 2007). Therefore, injury seen after early reproductive soybean is exposed to dicamba will primarily be noticed as leaf cupping because vegetative growth is still occurring at a rapid pace in indeterminate cultivars (Heatherly and Elmore 2004). When pod formation begins (R3), vegetative growth slows considerably, resulting in less visible soybean injury (Figure 4).

Although not tested statistically, the impact on soybean height and pod malformation seems to differ across growth stages (Figures 2 through 7). Reductions in height seem to be more common at earlier reproductive stages. As soybean plants approach maturity, there is less capacity for height reduction because plants are at or near maximum height. The percentage of soybean pods malformed was as high as 80% for R2, 70% for R3, and 60% for R1 drift events (Figures 2 through 4). Because all varieties used in these studies were indeterminate in growth habit, pod malformation was still noticed in the upper nodes of soybean plants at up to 15% for R4 and R5 and 5% for R6 drift trials (Figures 5 through 7).

Correlation analysis between wind and distance moved. An additional correlation analysis was performed between wind speed data during application and calculated distance to 5% soybean injury (data not shown). Neither maximum nor average wind speed was significantly correlated with the distance to 5% soybean injury. Although wind speed has been documented to greatly affect drift of pesticides, atmospheric conditions such as thermals, temperature, and humidity could play a vital role in dicamba off-target movement. Other research also observed the amount of 2,4-D drift (also a synthetic auxin) not to be solely dependent on average wind speeds (Wolf et al. 1992).

Previous research has examined several meteorological parameters and their effect on particle drift (Threadgill and Smith 1975). A distinct observation of greater drift when unstable atmospheres occurred at the time of application was documented; thus, temperature gradients involving lower temperatures at the crop lead to upward movement of air (thermals) to warmer temperature above the surface. The updraft essentially allowed for particles to remain suspended for longer periods of time. Furthermore, increased wind speeds lead to decreased particle drift in some cases because, as the authors suggest, the atmosphere becomes homogenized when warm and cool air masses mix, basically eliminating updrafts.

When temperatures are high (32 C and above) evaporation of spray droplets may occur before they reach their intended site (Maybank et al. 1974). The more solution that evaporates from a spray particle, the lighter it will become and therefore may travel further before deposition. In the case of dicamba, evaporation of its carrier could in turn lead to volatility. Volatility after application could have occurred because of the impact of temperature and humidity. However, Maybank et al. (1974) did not record temperature and humidity following application to use for analysis. In the present study, considerable upwind injury or injury in multiple directions was noticed in some applications, likely attributable to volatile movement of dicamba.

In addition to the effect of temperature on spray particle movement, environmental conditions at the time application and soon after could affect the extent of symptomology and ability of soybean plants to recover from dicamba exposure. Previous research documented that dry conditions increased the sensitivity of soybean to dicamba (Andersen et al. 2004; Auch and Arnold 1978; Kelley et al. 2005; Weidenhammer et al. 1989). Furthermore, higher temperatures near the time of exposure resulted in increased sensitivity of soybean to dicamba (Al-Khatib and Peterson 1999).

Non-linear regression models. Three-parameter exponential models were a good fit for relating soybean variables with distance from the applied area (Appendix Figures 1 through 25). Drift trials occurring at R6 were not included in this analysis because injury symptoms were only observed near the application, which resulted in these trials only spanning twenty meters from the treated area.

Soybean injury at 28 DAA was adequately described using the model, with all R^2 being greater than 0.91 for all trials, regardless of growth stage (Appendix Figures 1 through 5). Yet, because of differences in soybean sensitivity to dicamba among growth stages, trials must be compared within each growth stage. As expected, the distance that dicamba injury to soybean could be visibly detected decreased after flowering stages (R1-R2) (Table 3). For R1 applications, a maximum distance of 128.2 m was documented (maximum wind 19 km h^{-1}, average wind 16.9 km h^{-1}), with distance increasing to 152 m at R2 when wind speeds were less (maximum wind 15.4 km h^{-1}, average wind 11.1 km h^{-1}).

Height reduction at 28 DAA and at maturity followed similar trends as injury in that less height reduction was seen as application was delayed. Previous research documents that mature height reduction occurs more at early reproductive stages than at later reproductive stages (Auch and Arnold 1978). The distance to 5% harvest height reduction was greater than canopy height reduction at 28 DAA after R1 drift events but was less than or equal to R1 drift at later drift applications. The fact that average height reduction decreased from 28 DAA to maturity after R1 drift events indicates that soybean nodes added later than 28 days after R1 growth stage may be affected by dicamba. However, this parameter was not investigated in this study.

This research documents that height reduction to non-DR soybean can occur at greater distances than those listed on the Xtendimax and Engenia labels when AIXR 11003 nozzles are used with an output of 93.5 L ha^{-1}. In some cases, 5% height reduction occurred at over 80 m, which is over twice the required buffer for endangered species when using an approved nozzle.

The average distance to 5% pod malformation was numerically greater after R2 drift events than R1 drift events, indicating soybean could be more sensitive to pod malformation from dicamba drift at this stage. Pod malformation may be an indicator that dicamba has been translocated to pods and/or seeds. Previous research documented pod malformation to occur after exposure to dicamba and for subsequent offspring to be malformed in some cases (Barber et al. 2015; McCown et al. 2016b; Thompson and Egli 1973). Furthermore, auxin symptomology occurrence in newly planted soybean could be blamed on drift exposure, which may cause dicamba complaints to be filed where they are unwarranted.

Two trials after R1 drift events (33.9 m, 42.8 m), two trials after R2 drift events (40.9 m, 90.4 m), and one trial after a R3 drift event (33.5 m) were documented to cause 5% yield loss to soybean beyond the buffer distance established for endangered species at the field edge. Using the sprayer setup evaluated in this research, dicamba application in DR cotton and soybean may lead to yield loss beyond a 33.3 m buffer in the downwind direction and the risk may increase relative to the size of the treated area. In this research, no more than 480 m^2 were treated, and it should be noted that only a single pass of a sprayer was utilized. There would be opportunity to increase primary drift exposure to downwind species if multiple passes were used.

Based on label guidelines, application would be permissible where non-DR soybean is bordering DR cotton or soybean, but the wind direction would have to be directly away from sensitive crops such as non-DR soybean at the time of application (Anonymous 2017c; Anonymous 2017d). Even so, volatility of DGA dicamba, including the new formulations, can occur at least 3 days after application (Jacobson et al. 2016a; Jacobson et al. 2016b; Mueller et al. 2013). Because of volatilization and other forms of possible secondary movement, it is not possible to conclude that all of the injury or damage observed in these trials was solely the result of primary drift. With injury sometimes observed in directions other than those that were downwind at application, future efforts should try to quantify soybean response to the separate contributions of primary and secondary off-target movement of dicamba.

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Table 1. Correlation coefficients for soybean injury, height at 28 DAA, height at harvest, pod malformation, and yield after a diglycolamine dicamba drift event.[a]

	GS[b]	Injury at 28 DAA[c]	Height at 28 DAA[d]	Height at harvest[d]	Pod malformation[e]	Yield[d]
Injury at 28 DAA[b]	R1		-0.7777*	-0.6790*	0.8477*	-0.5055*
	R2		-0.1691*	-0.3989*	0.7887*	NS
	R3		-0.6153*	-0.3927*	0.6557*	-0.2673*
	R4		NS	-0.2203	0.5806*	-0.4575*
	R5		NS	NS	0.8401*	0.4315*
	R6		-	-	-	-
Height at 28 DAA[c]	R1	-0.7777*		0.8219*	-0.8589*	0.6157*
	R2	-0.1691*		0.412*	-0.3833*	0.0965
	R3	-0.6153*		0.4641*	-0.4734*	0.297*
	R4	NS		NS	0.284*	NS
	R5	NS		NS	NS	0.3105
	R6	-		-	-	-
Height at harvest[c]	R1	-0.6790*	0.8219*		-0.8314*	0.6687*
	R2	-0.3989*	0.412*		-0.5986*	0.1389
	R3	-0.3927*	0.4641*		-0.2268*	0.314*
	R4	-0.2203	NS		NS	NS
	R5	NS	NS		NS	0.3788*
	R6	-	-		NS	0.4622*
Pod malformation[d]	R1	0.8477*	-0.8589*	-0.8314*		-0.6535*
	R2	0.7887*	-0.3833*	-0.5986*		NS
	R3	0.6557*	-0.4734*	-0.2268*		-0.1122
	R4	0.5806*	0.284*	NS		-0.2991
	R5	0.8401*	NS	NS		0.3593*

Table 1 continued

	GS[b]	Injury at 28 DAA[c]	Height at 28 DAA[d]	Height at harvest[d]	Pod malformation[e]	Yield[d]
	R6	-	-	NS		NS
Yield[c]	R1	-0.5055	0.6157	0.6687	-0.6535	
	R2	NS	0.0965	0.1389	NS	
	R3	-0.2673*	0.297*	0.314*	-0.1122	
	R4	-0.4575*	NS	NS	-0.2991	
	R5	0.4315*	0.3105	0.3788*	0.3593*	
	R6	-	-	0.4622*	NS	

Abbreviations: DAA = days after application; GS = growth stage; * = significance to $\alpha \leq 0.01$; NS = not significant

[a]Correlation coefficients were computed on a pairwise method

[b]Sample sizes: R1(481), R2(557), R3(333), R4(118), R5(81), R6(66)

[c]Soybean injury was rated on a 0 to 100% scale with 100% being plant death

[d]Heights and yield were converted to a percentage of the uninjured, with the uninjured being the average of 3 random plots within each trial having no injury at 28 DAA

[e]Pod malformation ratings were taken as a percentage of pods malformed per plant

Table 2. Correlation coefficient confidence intervals (95%) for soybean injury, height at 28 DAA, height at harvest, pod malformation, and yield.

		Injury at 28 DAA[a]		Height at 28 DAA[b]		Height at harvest[b]		Pod malformation[c]		Yield[b]	
	GS[d]	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
Injury at 28 DAA[a]	R1			-0.811	-0.7393	-0.7255	-0.6264	0.8205	0.8711	-0.5692	-0.4358
	R2			-0.2521	-0.0837	-0.4667	-0.3265	0.755	0.8182	-	-
	R3			-0.6787	-0.5427	-0.4814	-0.2959	0.5897	0.713	-0.3658	-0.1629
	R4			-	-	-0.3857	-0.0411	0.4467	0.689	-0.5969	-0.2914
	R5			-	-	-	-	0.7603	0.908	0.174	0.6337
	R6			-	-	-	-	-	-	-	-
Height at 28 DAA[b]	R1	-0.811	-0.7393			0.7894	0.8498	-0.8808	-0.8332	0.5564	0.6688
	R2	-0.2521	-0.0837			0.3372	0.4816	-0.455	-0.3067	0.0098	0.1828
	R3	-0.6787	-0.5427			0.3727	0.5466	-0.5538	-0.3842	0.1942	0.3934
	R4	-	-			-	-	0.1089	0.4421	-	-
	R5	-	-			-	-	-	-	0.0352	0.542
	R6	-	-			-	-	-	-	-	-
Height at harvest[b]	R1	-0.7255	-0.6264	0.7894	0.8498			-0.8577	-0.8008	0.6147	0.7164
	R2	-0.4667	-0.3265	0.3372	0.4816			-0.6495	-0.5424	0.0554	0.2204
	R3	-0.4814	-0.2959	0.3727	0.5466			-0.328	-0.1205	0.2106	0.4104
	R4	-0.3857	-0.0411	-	-			-	-	-	-
	R5	-	-	-	-			-	-	0.1596	0.5624
	R6	-	-	-	-			-	-	0.2138	0.6544
Pod malformation[c]	R1	0.8205	0.8711	-0.8808	-0.8332	-0.8577	-0.8008			-0.7019	-0.5991
	R2	0.755	0.8182	-0.455	-0.3067	-0.6495	-0.5424			-	-
	R3	0.5897	0.713	-0.5538	-0.3842	-0.328	-0.1205			-0.2186	-0.0031
	R4	0.4467	0.689	0.1089	0.4421	-	-			-0.4642	-0.114
	R5	0.7603	0.908	-	-	-	-			0.1375	0.5468

Table 2 continued

	GS[d]	Injury at 28 DAA[a] Lower	Injury at 28 DAA[a] Upper	Height at 28 DAA[b] Lower	Height at 28 DAA[b] Upper	Height at harvest[b] Lower	Height at harvest[b] Upper	Pod malformation[c] Lower	Pod malformation[c] Upper	Yield[b] Lower	Yield[b] Upper
	R6	-	-	-	-	-	-			-	-
Yield[b]	R1	-0.5692	-0.4358	0.5564	0.6688	0.6147	0.7164	-0.7019	-0.5991		
	R2	-	-	0.0098	0.1828	0.0554	0.2204	-	-		
	R3	-0.3658	-0.1629	0.1942	0.3934	0.2106	0.4104	-0.2186	-0.0031		
	R4	-0.5969	-0.2914	-	-	-	-	-0.4642	-0.114		
	R5	0.174	0.6337	0.0352	0.542	0.1596	0.5624	0.1375	0.5468		
	R6	-	-	-	-	0.2138	0.6544	-	-		

Abbreviations: DAA = days after application; GS = growth stage

[a]Soybean injury was rated on a 0 to 100% scale with 100% being plant death

[b]Heights and yield were converted to a percentage of the uninjured, with the uninjured being the average of 3 random plots within each trial having no injury at 28 DAA

[c]Pod malformation ratings were rated as a percentage of pods malformed per plant

[d]Sample sizes: R1(481), R2(557), R3(333), R4(118), R5(81), R6(66)

Table 3. Growth stage, and maximum and average wind speeds during application and the calculated distance to 5% observed soybean injury, 5% reduction in height at 28 days after application, 5% reduction in height at harvest, 5% pod malformation, and 5% reduction in yield for drift trials.[ab]

Growth stage	Trial	Wind speeds during application[c] Maximum	Wind speeds during application[c] Average	Calculated distance to 5% soybean injury	Calculated distance to 5% height reduction at 28 DAA	Calculated distance to 5% height reduction at harvest	Calculated distance to 5% pod malformation at harvest	Calculated distance to 5% yield reduction
		------km h^{-1}------		------m------				
R1	1	19.0	16.9	128.2	49.6	72.8	85.6	25.9
	2	19.8	15.1	94.1	42.1	79.2	54.4	14.6
	3	19.3	16.3	91.6	38.5	75.1	66.3	33.9
	4	18.0	15.8	120.1	83.0	51.5	77.6	9.7
	5	16.8	12.1	75.1	52.1	24.0	41.4	18.5
	6	15.3	16.3	64.4	36.8	83.4	49.6	42.8
R2	7	14.5	12.6	36.4	53.3[d]	42.4	40.6	40.9
	8	17.7	14.9	85.5	34.0	36.6	52.4	10.1
	9	11.9	10.2	116.7	54.3	23.4	95.0	0[e]
	10	15.4	11.1	152.0	14.5	17.0	139.5	3.7
	11	12.9	12.1	60.6	0[e]	15.4	60.6	90.4[d]
	12	13.7	8.5	30.3	-[f]	0[e]	36.2	0[e]
R3	13	10.5	9.1	39.2	8.2	6.6	25.1	5.7
	14	15.3	14.0	30.0	0[e]	0[e]	27.9	11.2
	15	21.2	16.2	61.0[d]	36.2	7.5	34.1	0[e]
	16	14.6	12.6	50.3	24.1	22.1	23.4	33.5

Table 3 continued

Growth Stage	Trial	Wind speeds during application[c] Maximum	Average	Calculated distance to 5% soybean injury	Calculated distance to 5% height reduction at 28 DAA	Calculated distance to 5% height reduction at harvest	Calculated distance to 5% pod malformation at harvest	Calculated distance to 5% reduction in yield
	17	14.3	11.2	16.5	0[e]	0[e]	18.1	0[e]
R4	18	15.6	13.1	17.0	0[e]	0[e]	22.7	10.2
	19	14.6	13.4	16.1	8.2	0[e]	2.8	0[e]
R5	20	14.6	13.4	27.0	0[e]	0[e]	15.7	0[e]

[a]Trials with less than 5 data points were excluded from the analysis
[b]Distances were calculated using the reverse prediction function in JMP Pro 13 (SAS Institute, Cary, NC)
[c]Wind speeds were recorded at 1 sec intervals during application.
[d]Value recorded from the equation resulted in extrapolation; therefore, the furthest distance where data were recorded is used.
[e]Not a significant regression; therefore, a distance of 0 m was used.
[f]Data not recorded.

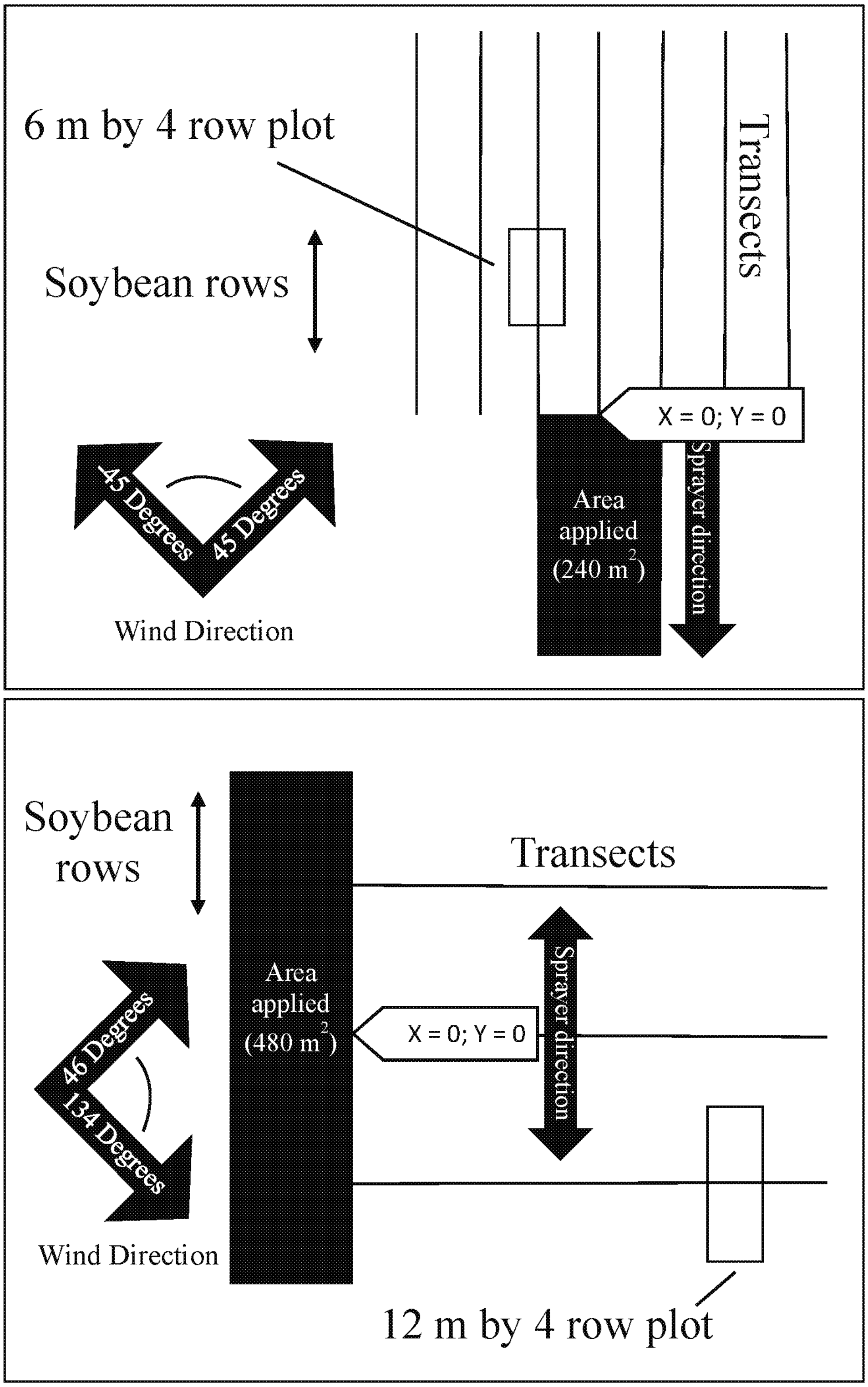


Figure 1. Design of drift trials with wind predominately occurring (A) down rows and (B) across rows.

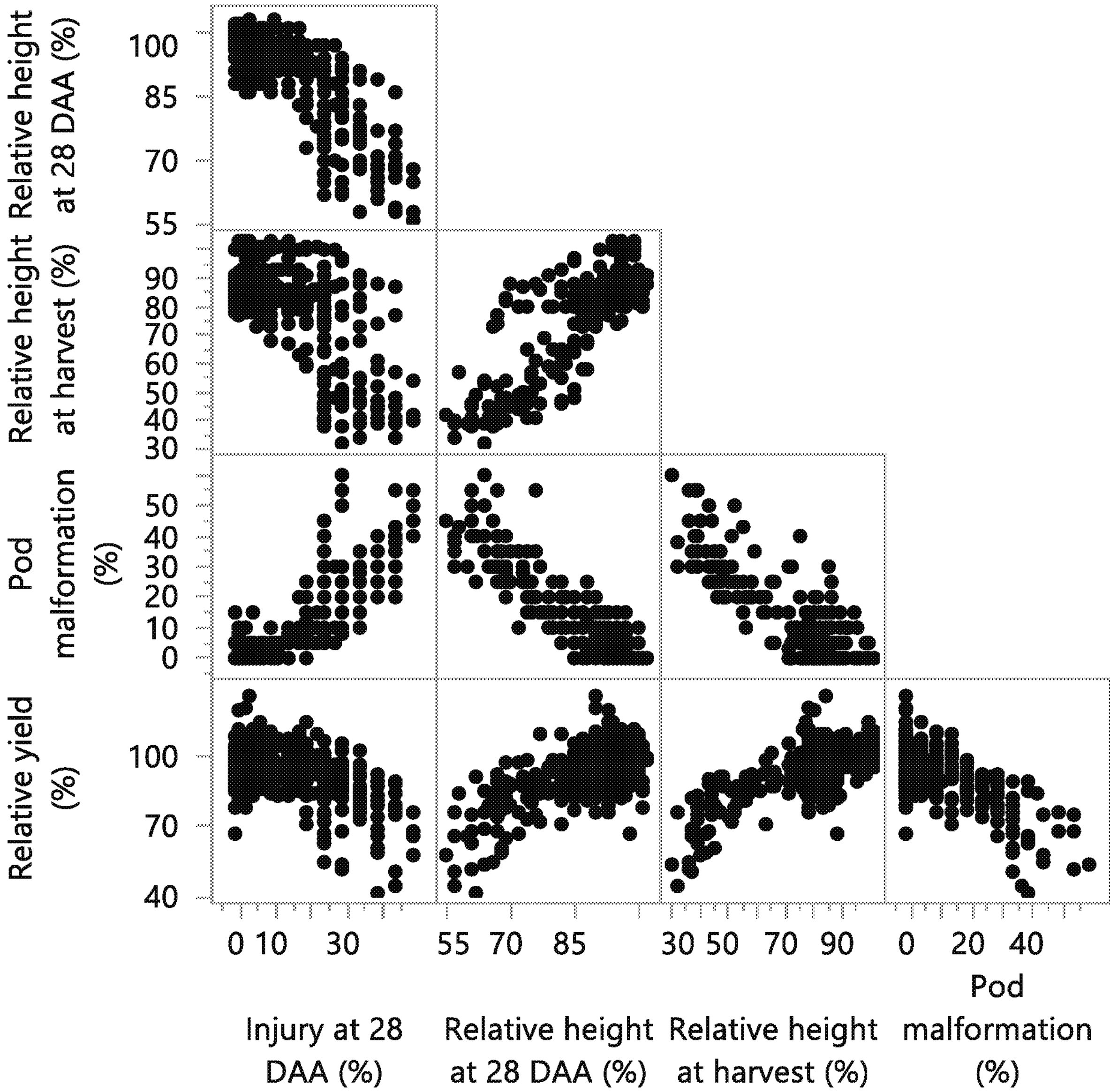


Figure 2. Scatterplot matrix of soybean observations after a diglycolamine dicamba drift event at R1. Heights and yield are reported as percentage of the uninjured. Uninjured is referring to the average of three random plots outside of the drift plume that were recorded to have no visual injury at 28 DAA.

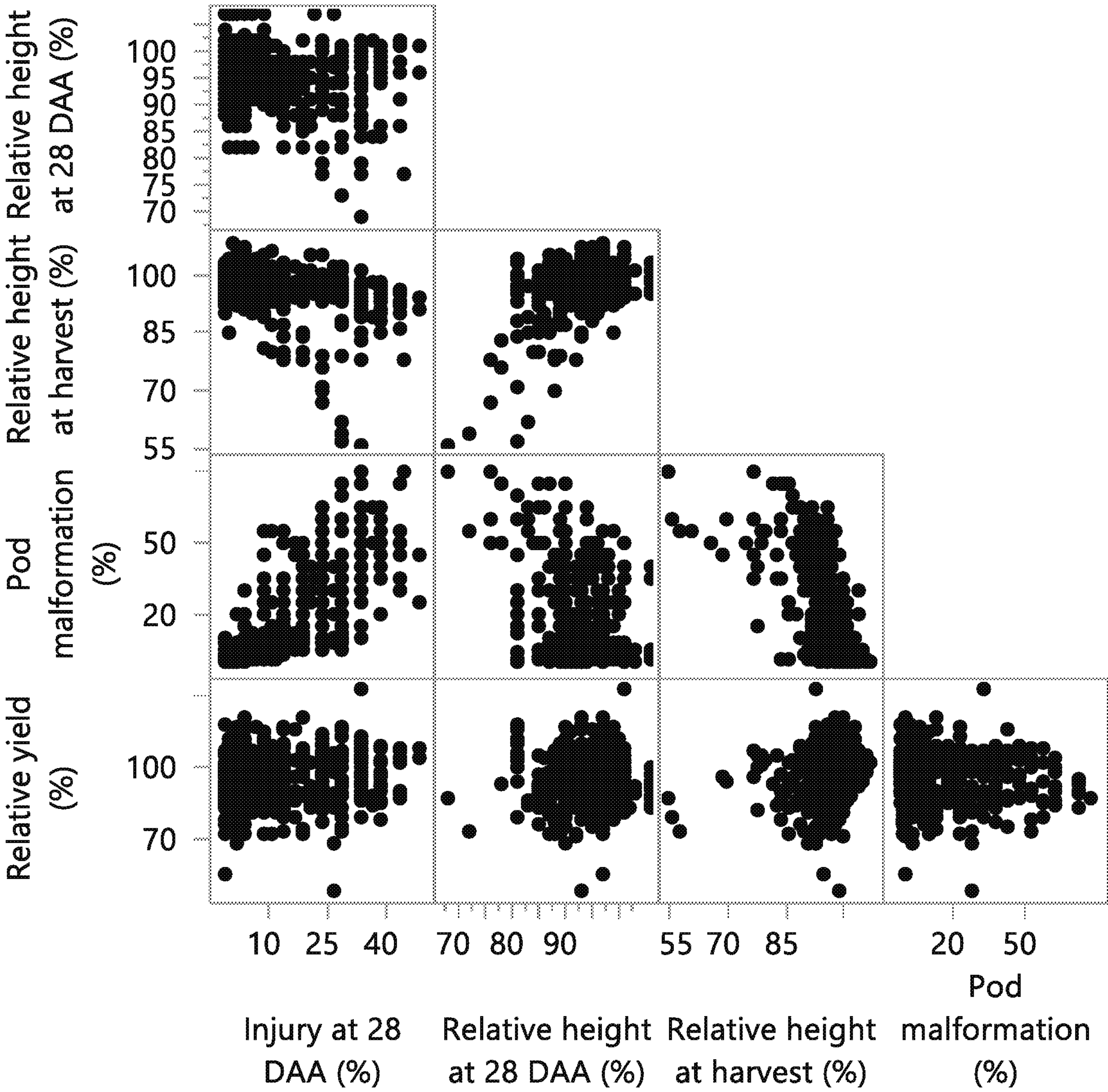


Figure 3. Scatterplot matrix of soybean observations after a diglycolamine dicamba drift event at R2. Heights and yield are reported as percentage of the uninjured. Uninjured is referring to the average of three random plots outside of the drift plume that were recorded to have no visual injury at 28 DAA.

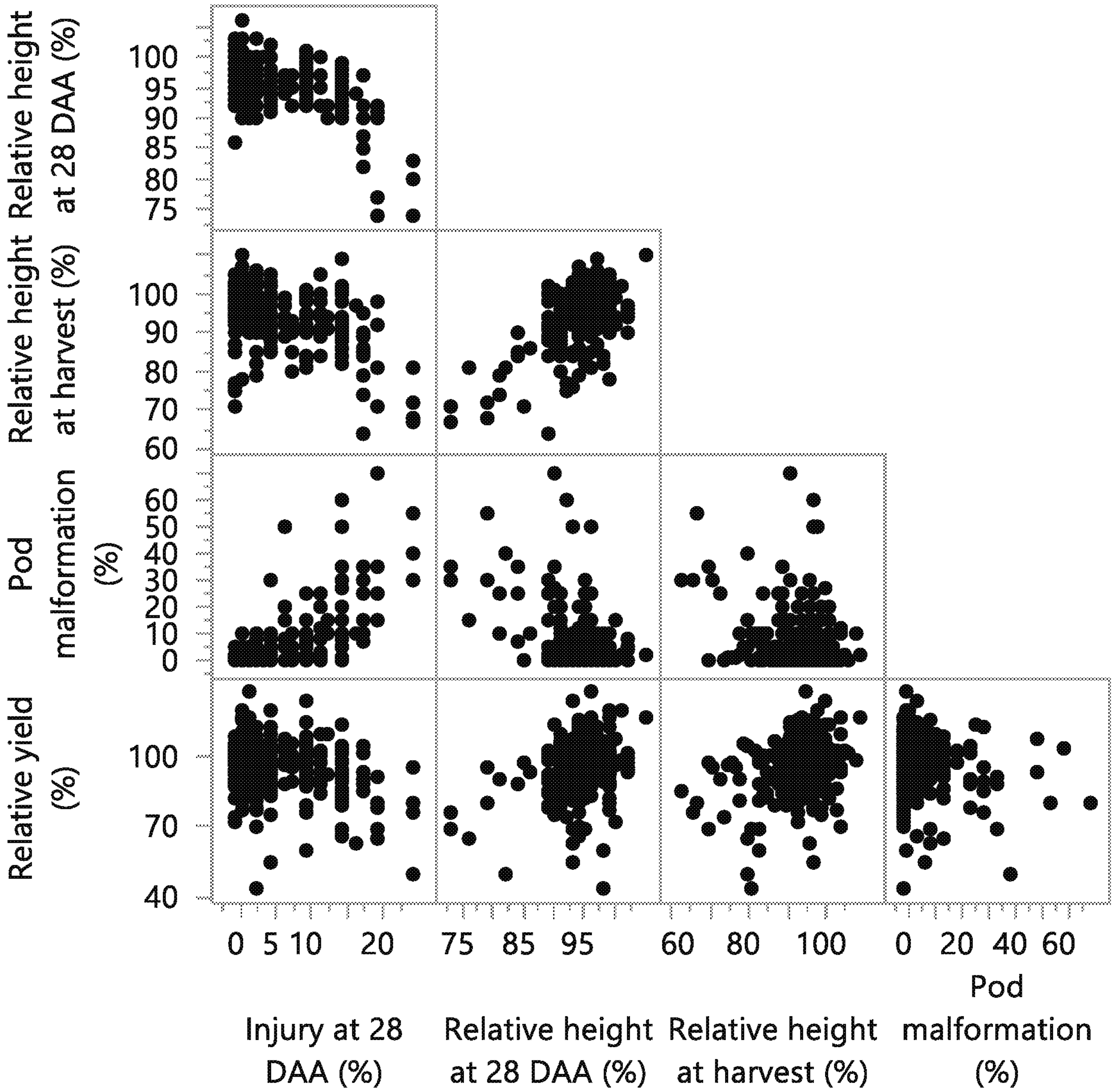


Figure 4. Scatterplot matrix of soybean observations after a diglycolamine dicamba drift event at R3. Heights and yield are reported as percentage of the uninjured. Uninjured is referring to the average of three random plots outside of the drift plume that were recorded to have no visual injury at 28 DAA.

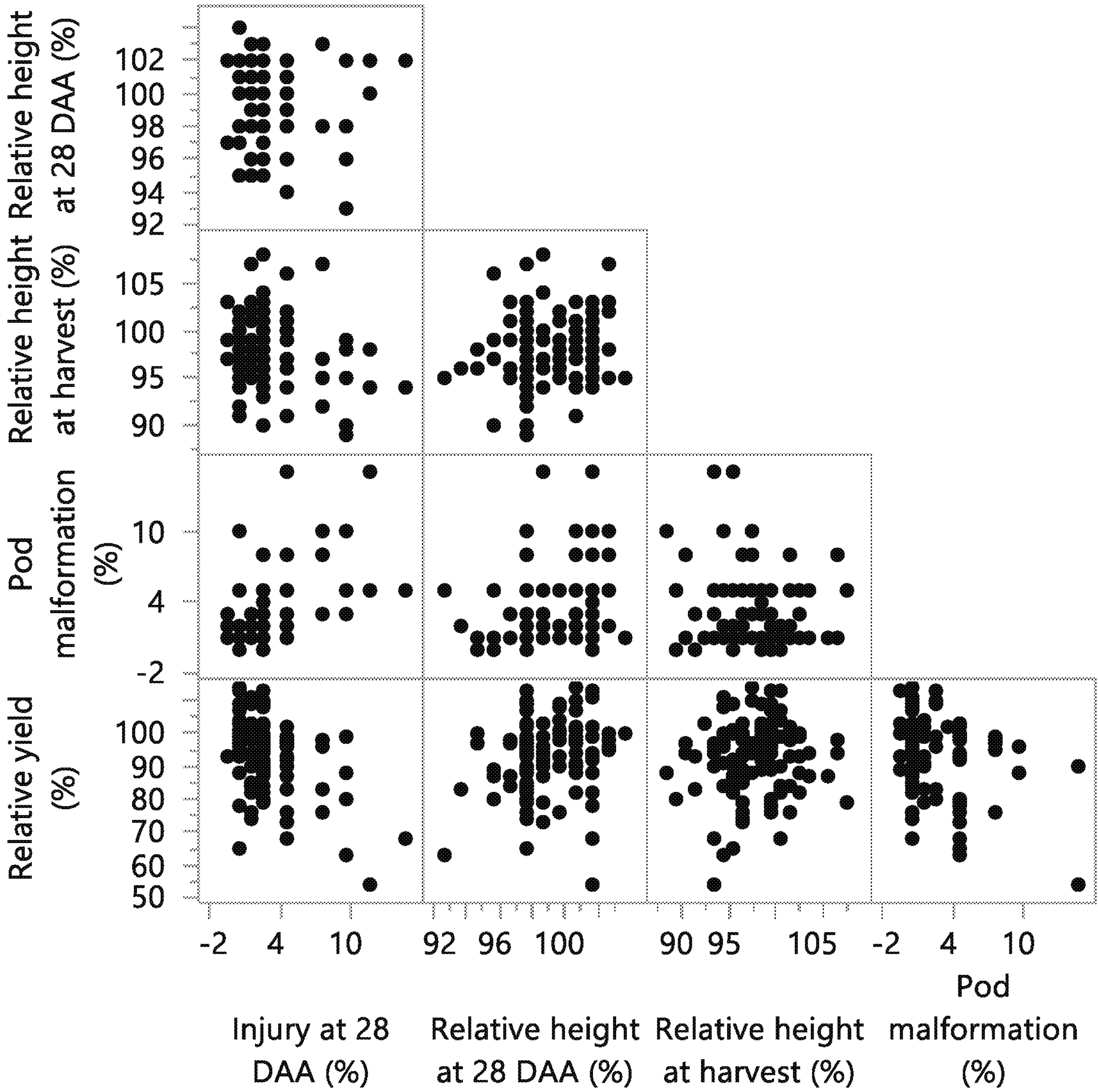


Figure 5. Scatterplot matrix of soybean observations after a diglycolamine dicamba drift event at R4. Heights and yield are reported as percentage of the uninjured. Uninjured is referring to the average of three random plots outside of the drift plume that were recorded to have no visual injury at 28 DAA.

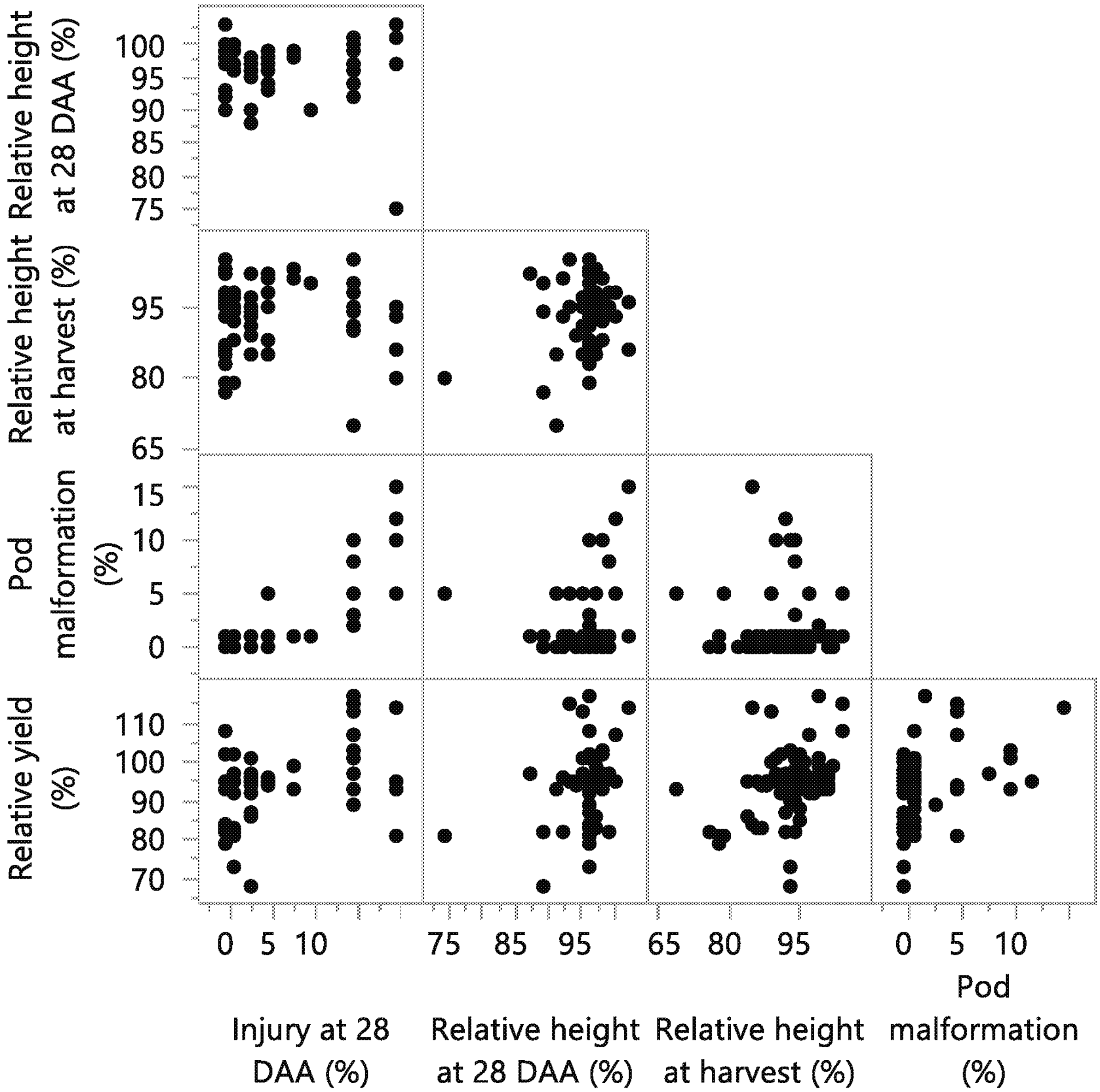


Figure 6. Scatterplot matrix of soybean observations after a diglycolamine dicamba drift event at R5. Heights and yield are reported as percentage of the uninjured. Uninjured is referring to the average of three random plots outside of the drift plume that were recorded to have no visual injury at 28 DAA.

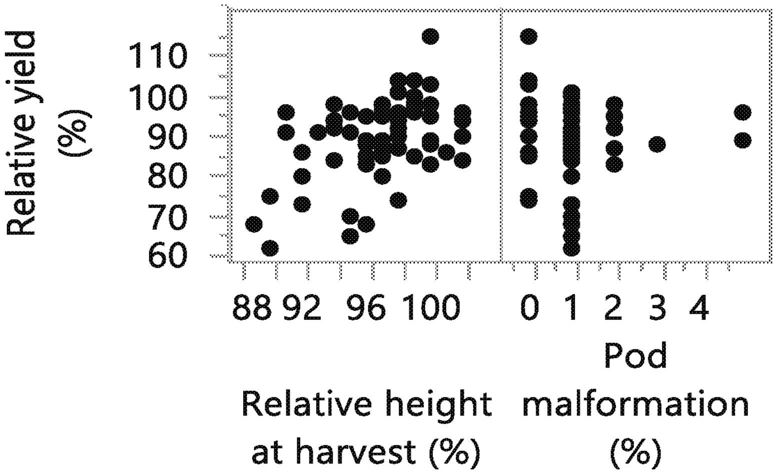
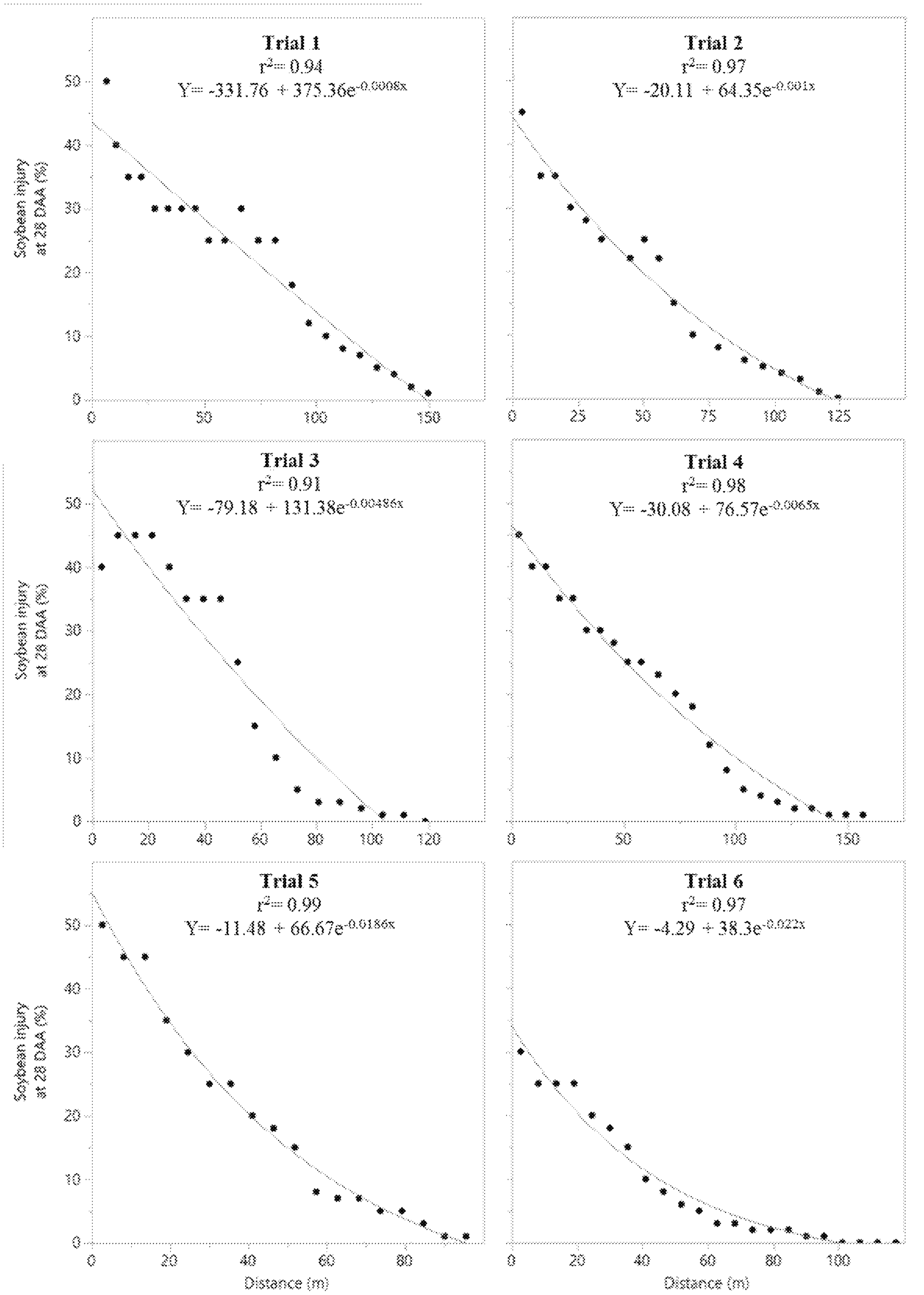
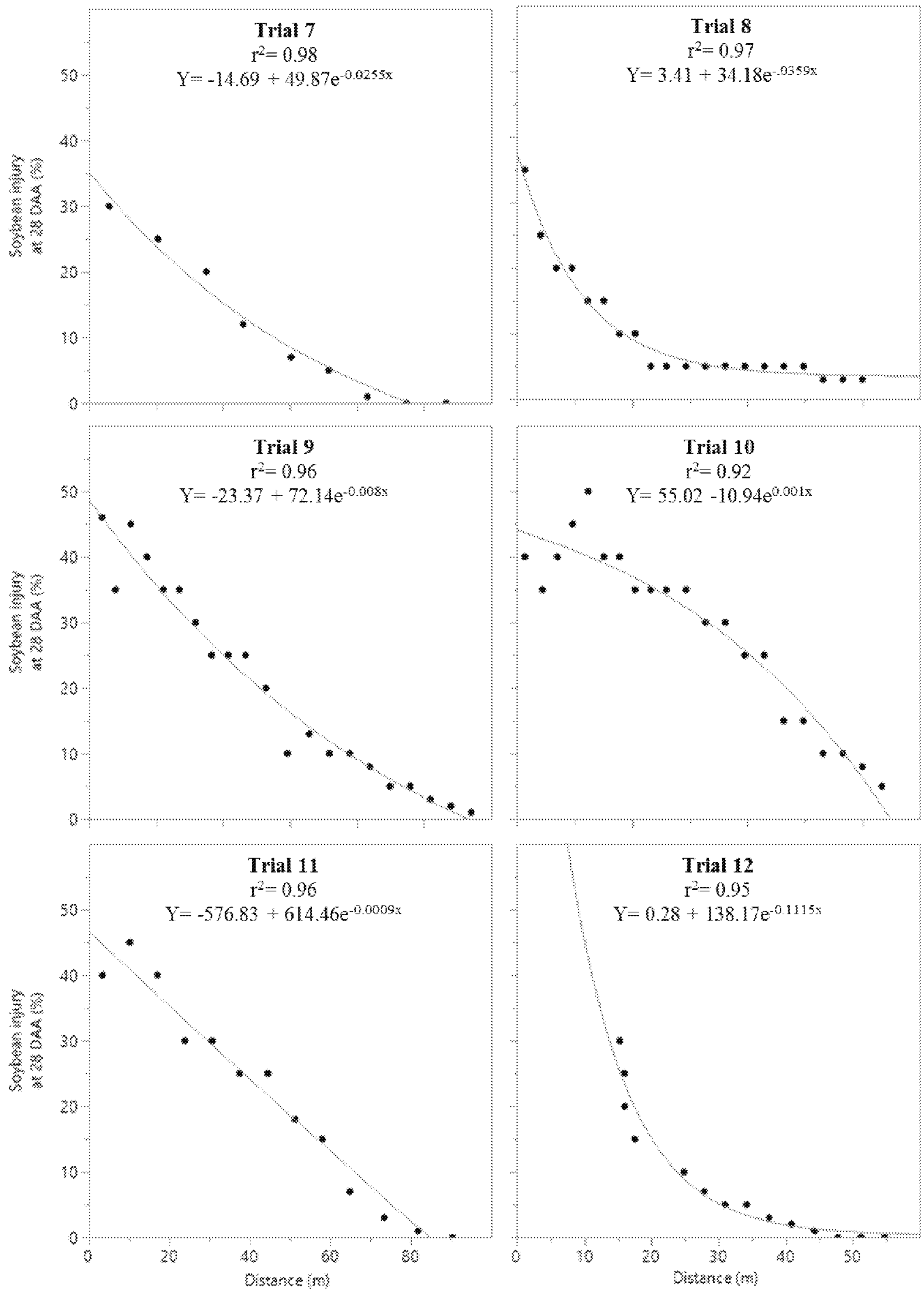


Figure 7. Scatterplot matrix of soybean observations after a diglycolamine dicamba drift event at R6. Measurements at 28 days after application (DAA) were not taken for R6 drift trials due to soybean leaf drop as the crop was approaching maturity. Heights and yield are reported as percentage of the uninjured. Uninjured is referring to the average of three random plots outside of the drift plume that were recorded to have no visual injury at 28 DAA.

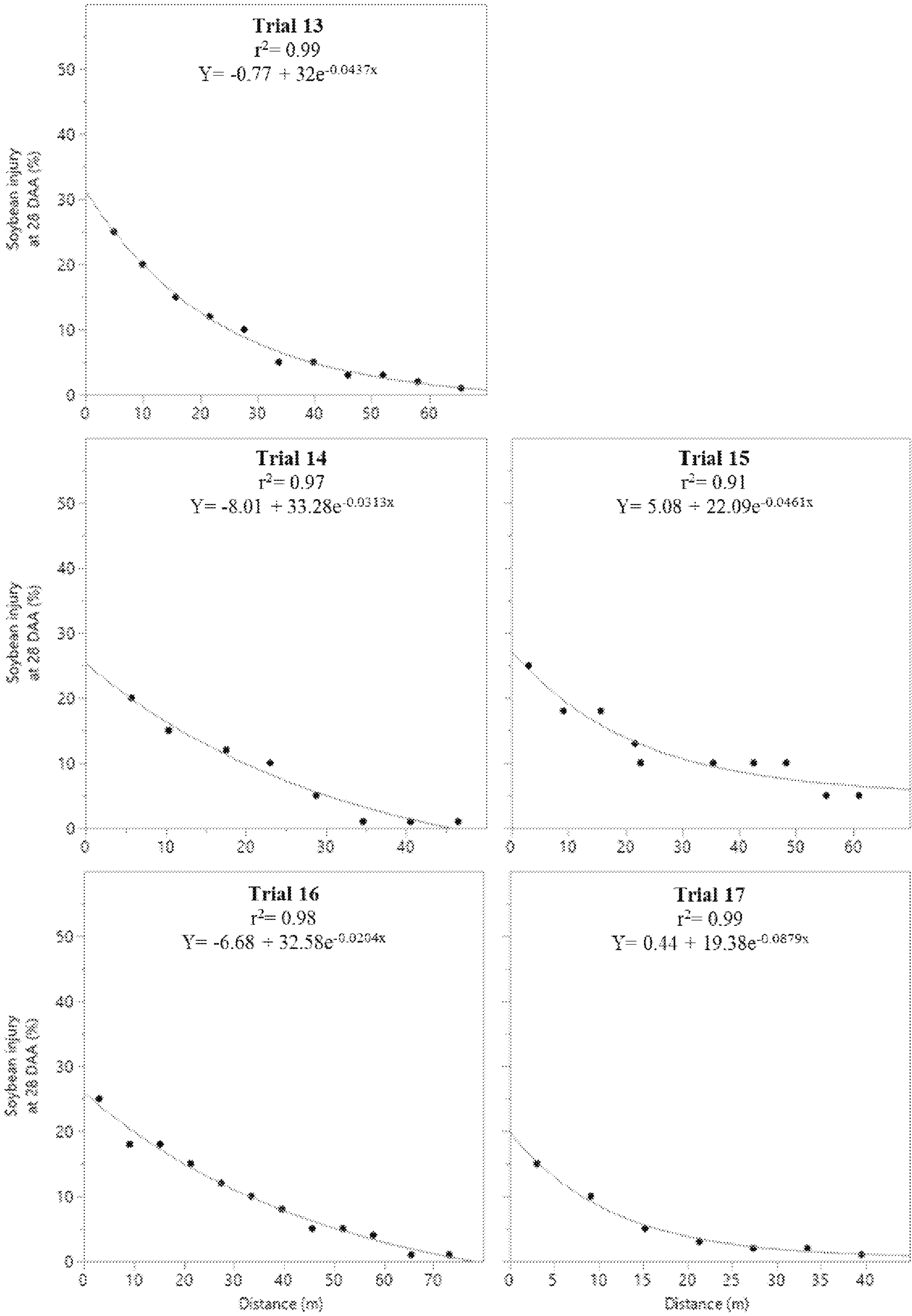
Chapter 1 Appendices



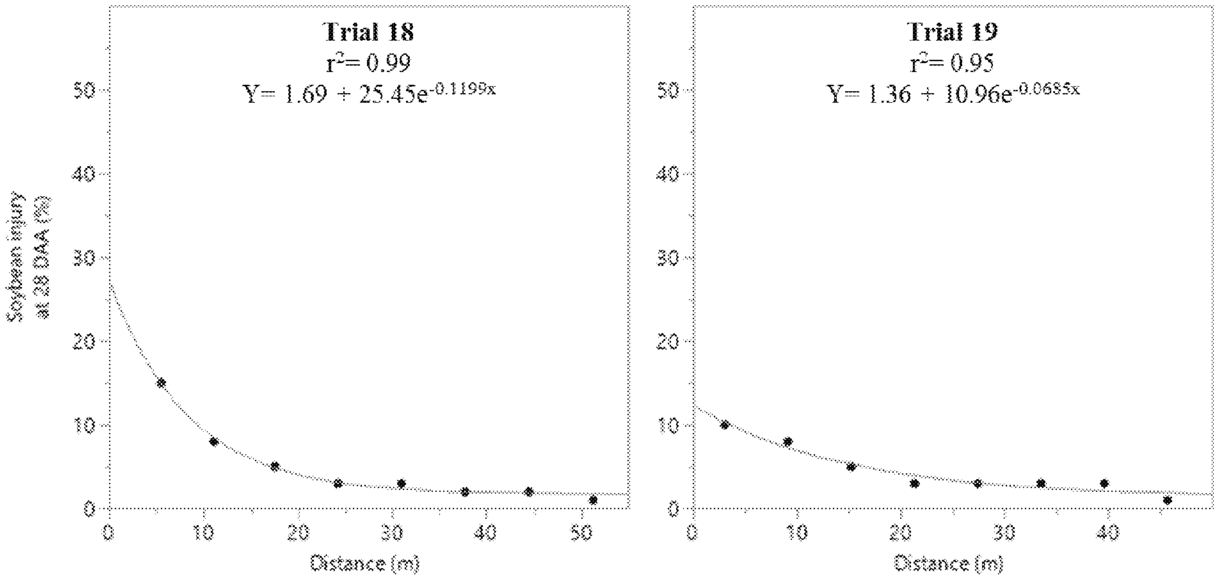
Appendix Figure 1. The relationship between downwind distance and soybean injury at 28 days after application (DAA) for R1 drift events ($\alpha = 0.05$). Soybean injury was rated on a scale from 0 to 100% with 0% being no injury and 100% being plant death.



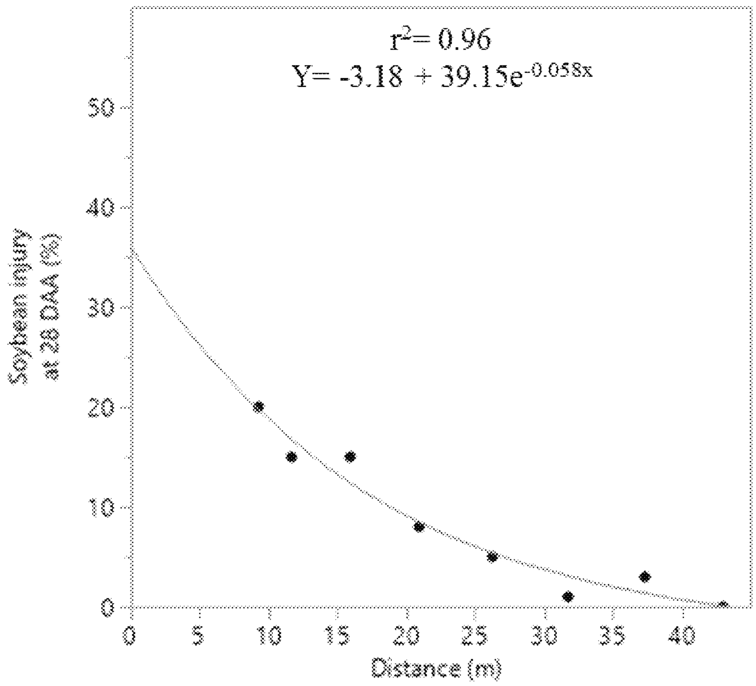
Appendix Figure 2. The relationship between downwind distance and soybean injury at 28 days after application (DAA) for R2 drift events (α= 0.05). Soybean injury was rated on a scale from 0 to 100% with 0% being no injury and 100% being plant death.



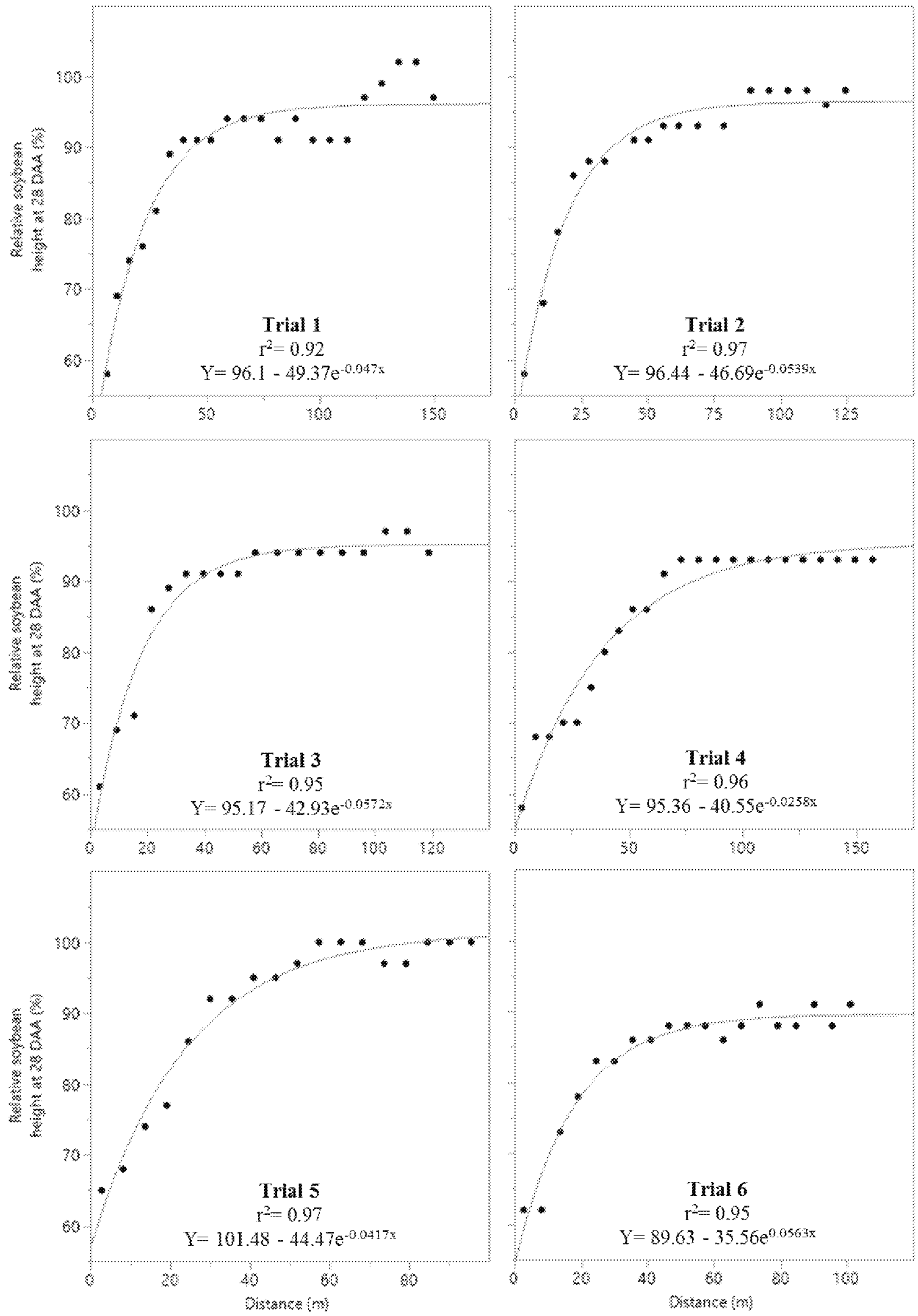
Appendix Figure 3. The relationship between downwind distance and soybean injury at 28 days after application (DAA) for R3 drift events (α= 0.05). Soybean injury was rated on a scale from 0 to 100% with 0% being no injury and 100% being plant death.



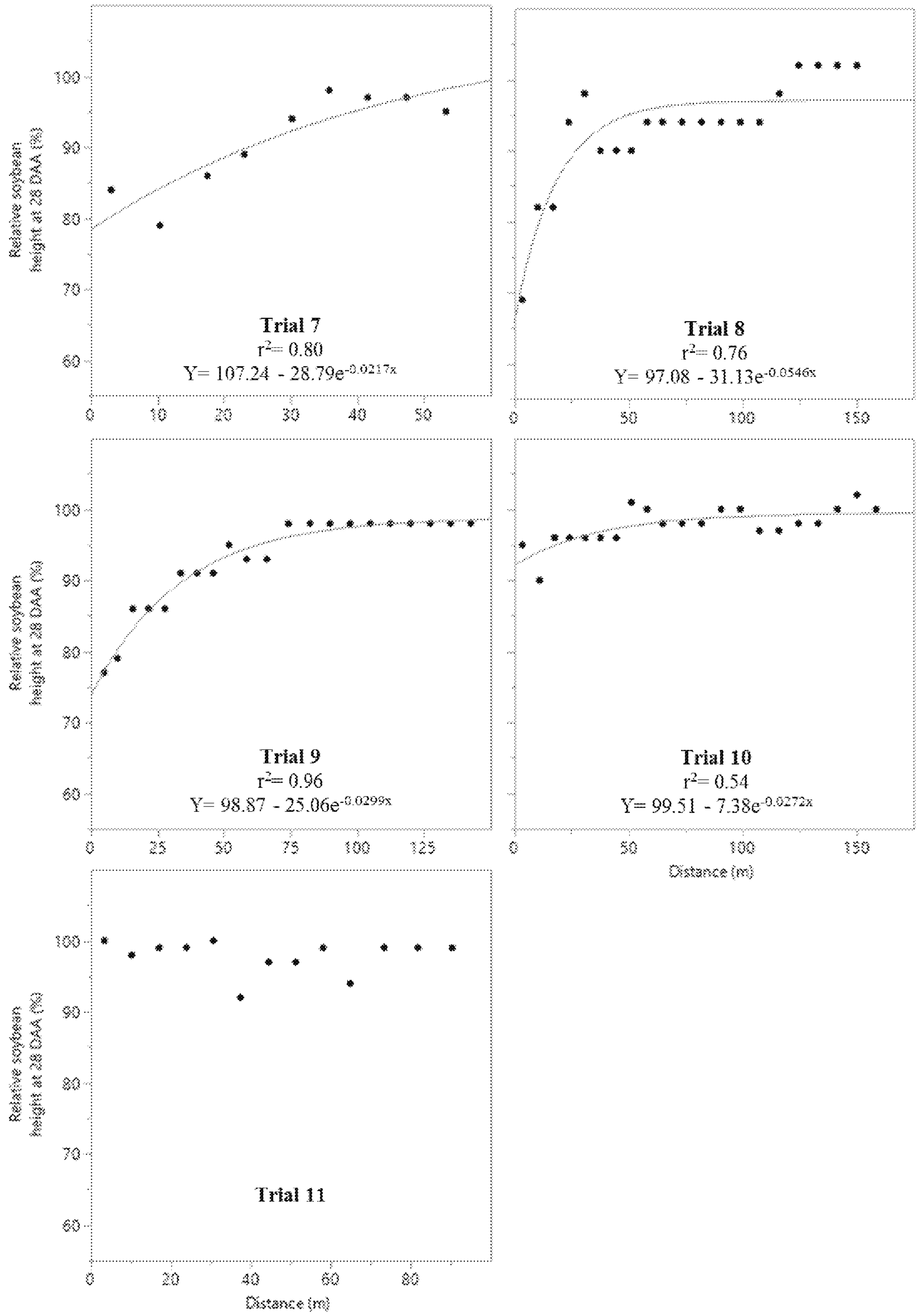
Appendix Figure 4. The relationship between downwind distance and soybean injury at 28 days after application (DAA) for R4 drift events (α= 0.05). Soybean injury was rated on a scale from 0 to 100% with 0% being no injury and 100% being plant death.



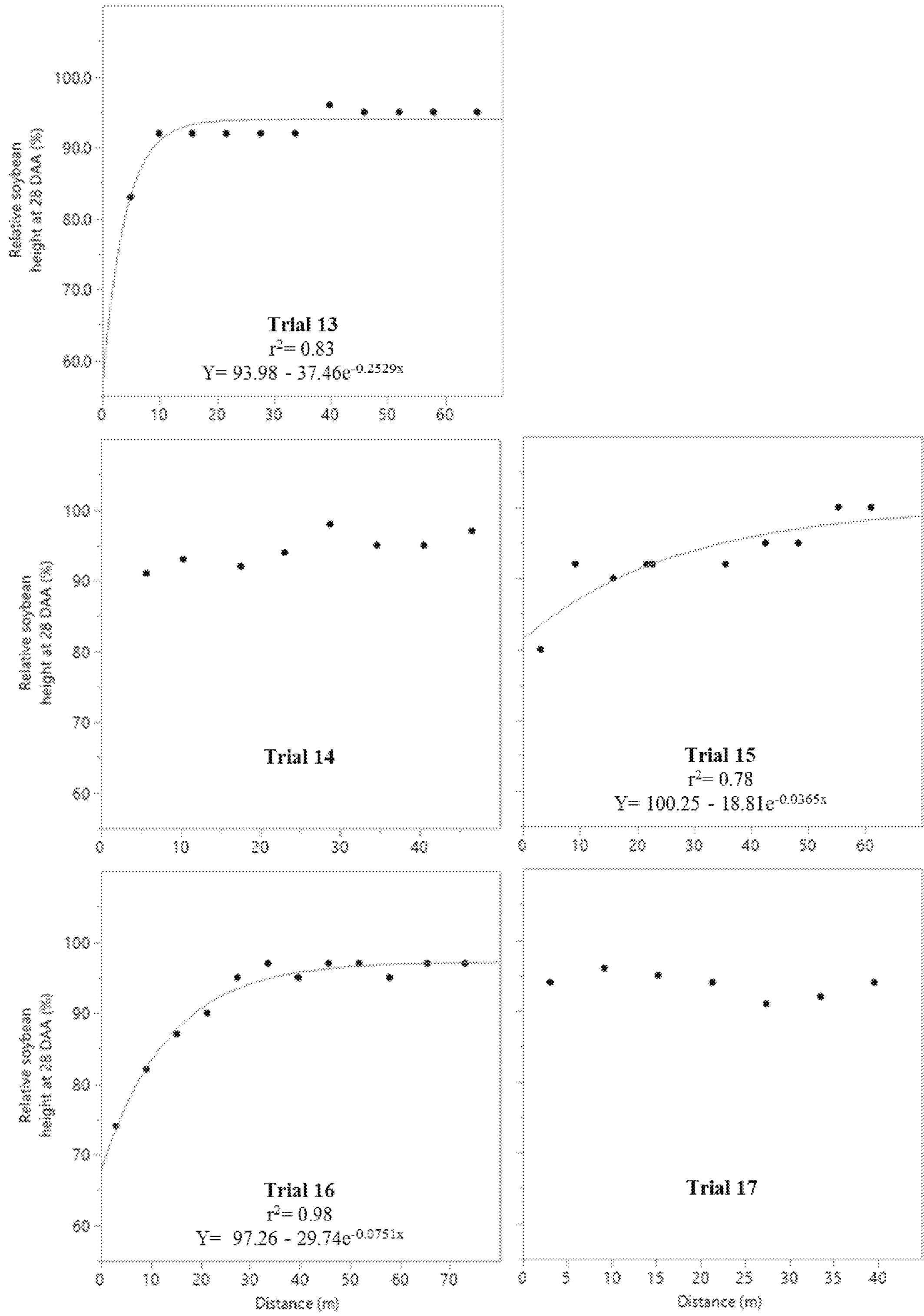
Appendix Figure 5. The relationship between downwind distance and soybean injury for trial 20 (R5) ($\alpha = 0.05$). Soybean injury was rated on a scale from 0 to 100% with 0% being no injury and 100% being plant death.



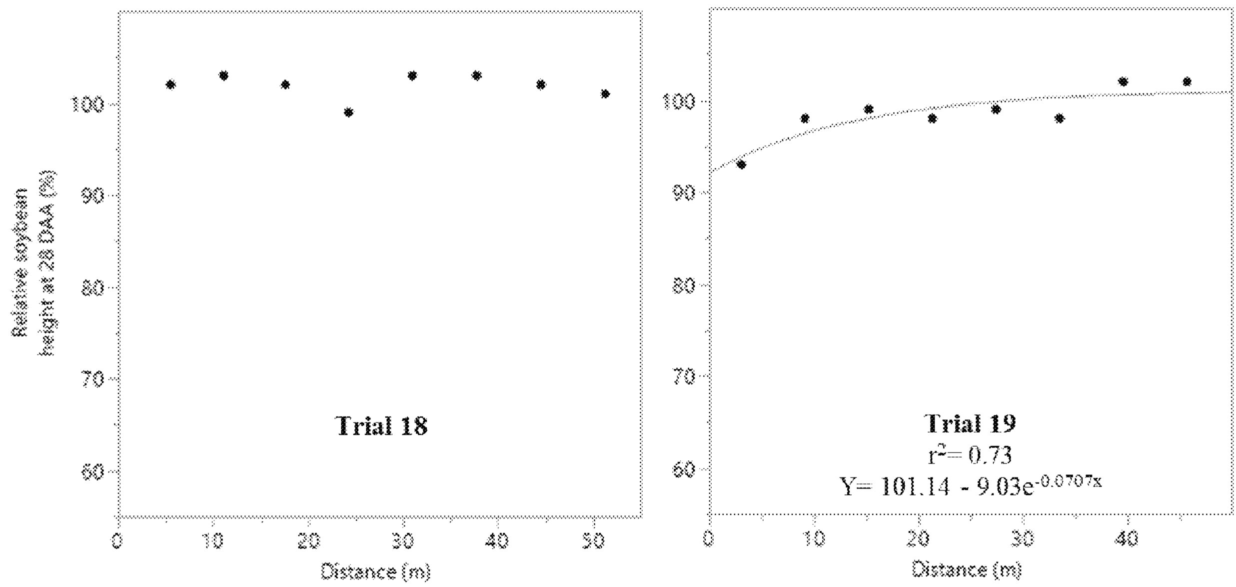
Appendix Figure 6. The relationship between downwind distance and soybean height at 28 days after application (DAA) for R1 drift events (α= 0.05). Soybean height was converted to a percent of the uninjured. The uninjured was the average height at 28 DAA of 3 random plots with no injury at 28 DAA.



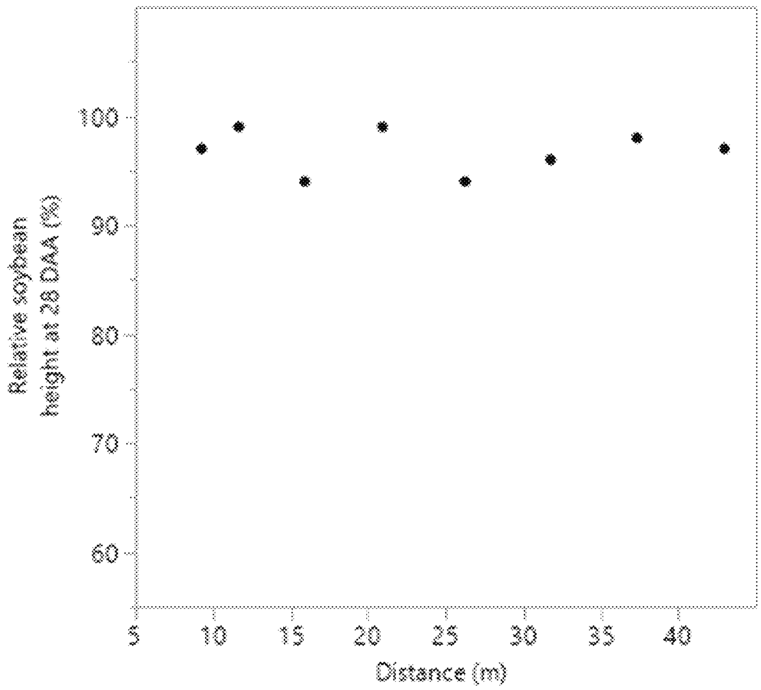
Appendix Figure 7. The relationship between downwind distance and soybean height at 28 days after application (DAA) for R2 drift events (α= 0.05). Soybean height was converted to a percent of the uninjured. The uninjured was the average height at 28 DAA of 3 random plots with no injury at 28 DAA. Trial 11 was not significant. Trial 12 is not shown because height data at 28 DAA was not taken.



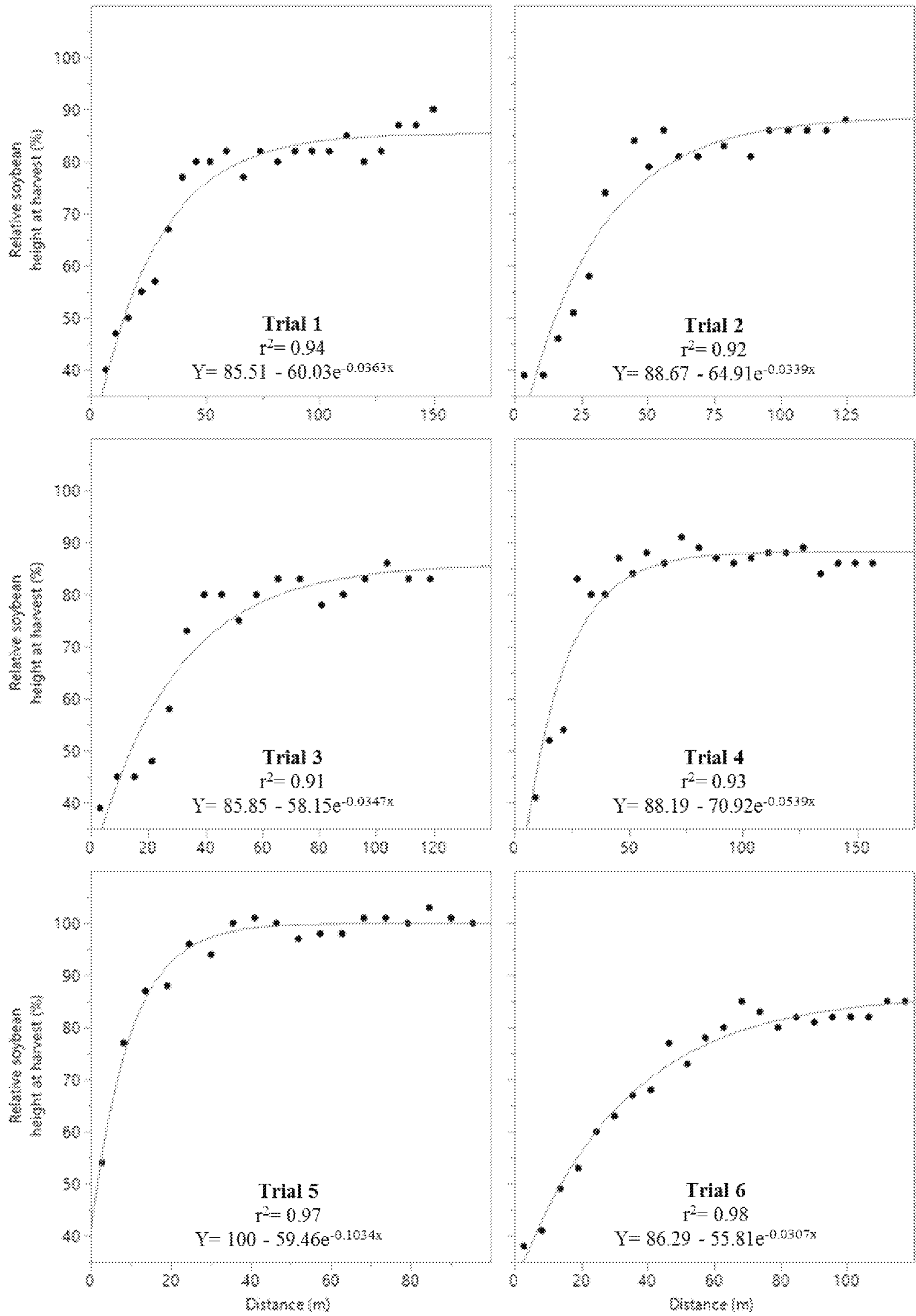
Appendix Figure 8. The relationship between downwind distance and soybean height at 28 days after application (DAA) for R3 drift events (α= 0.05). Soybean height was converted to a percent of the uninjured. The uninjured was the average height at 28 DAA of 3 random plots with no injury at 28 DAA. Trials 14 and 17 were not significant.



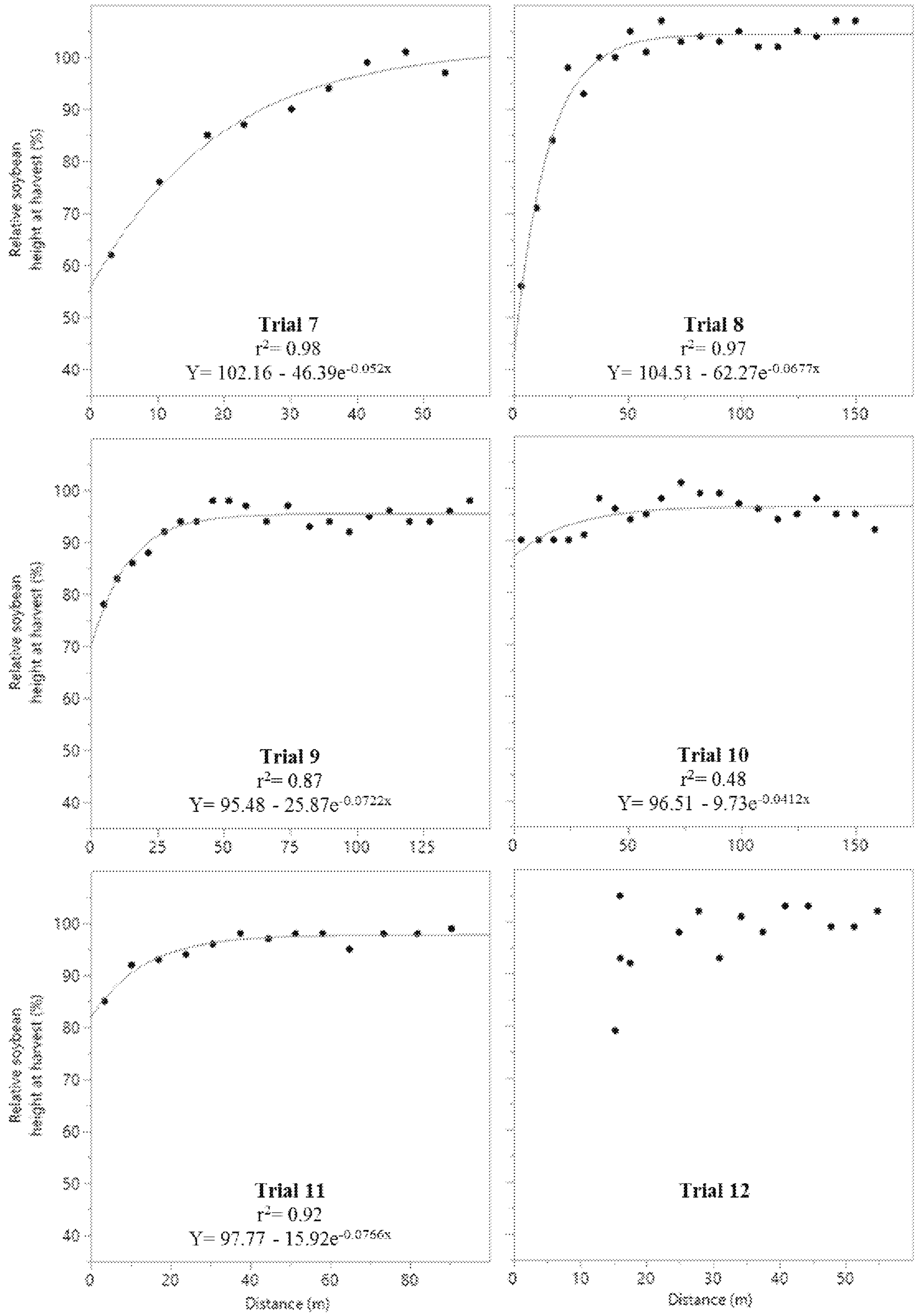
Appendix Figure 9. The relationship between downwind distance and soybean height at 28 days after application (DAA) for R4 drift events (α= 0.05). Soybean height was converted to a percent of the uninjured. The uninjured was the average height at 28 DAA of 3 random plots with no injury at 28 DAA. Trial 18 was not significant.



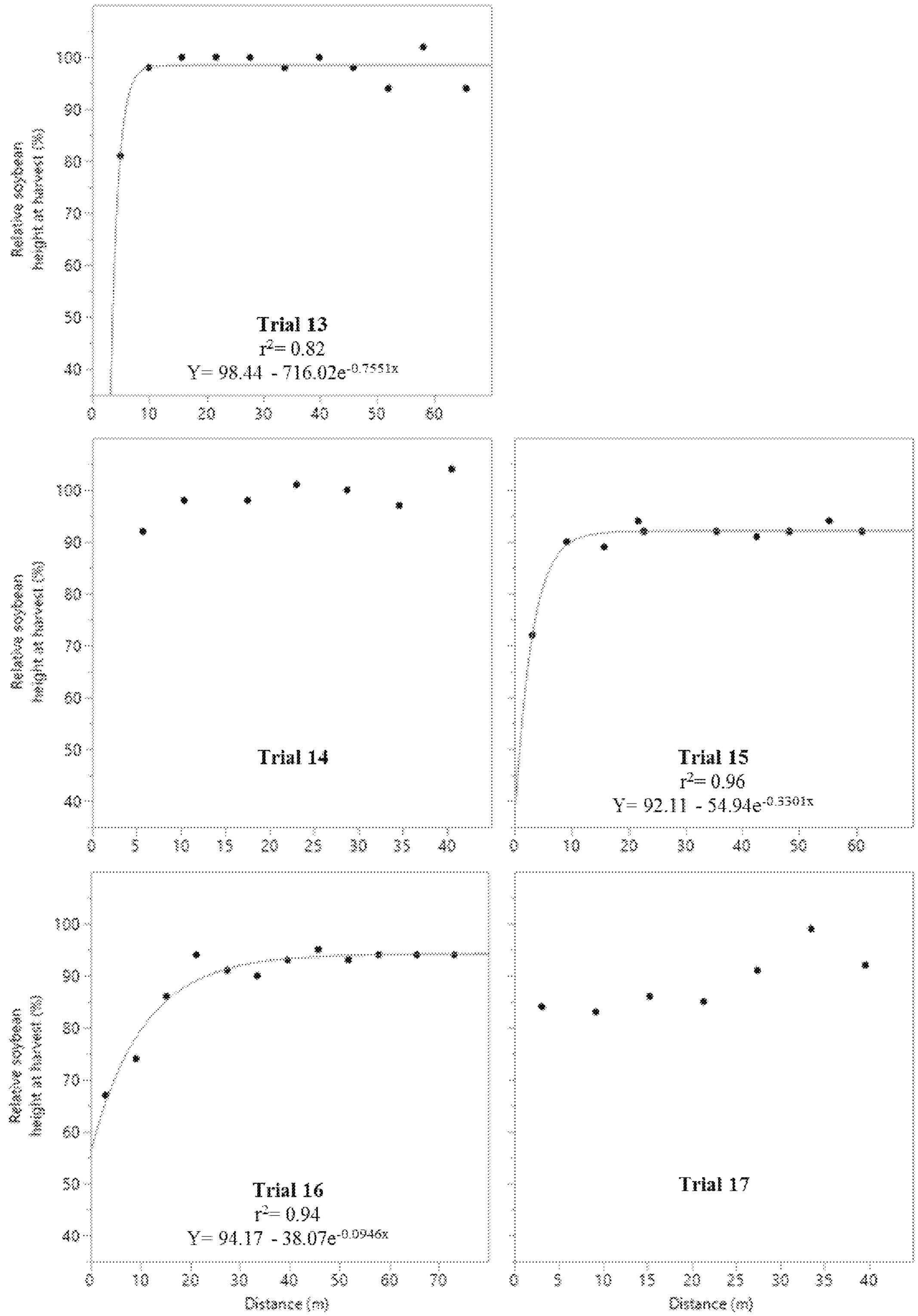
Appendix Figure 10. The relationship between downwind distance and height at 28 days after application (DAA) for trial 20 (R5) (α= 0.05). Soybean height was converted to a percent of the uninjured. The uninjured was the average height at 28 DAA of 3 random plots with no injury at 28 DAA. Trial 20 was not significant.



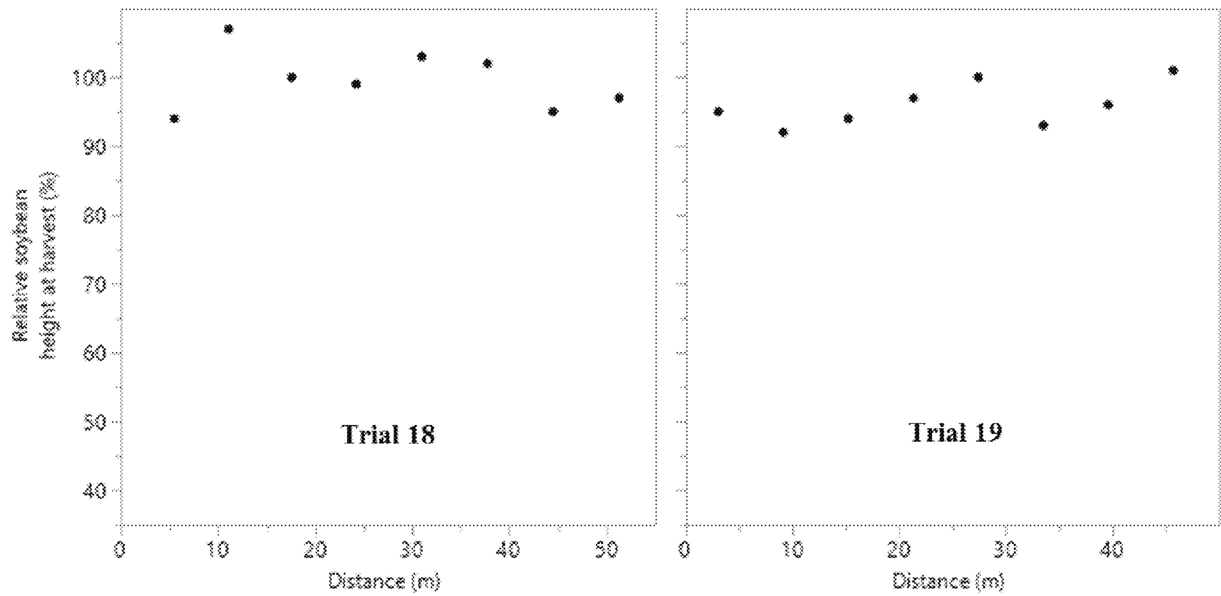
Appendix Figure 11. The relationship between downwind distance and soybean height at maturity for R1 drift events (α= 0.05). Soybean height was converted to a percent of the uninjured. The uninjured was the average height at maturity of 3 random plots with no injury at 28 DAA.



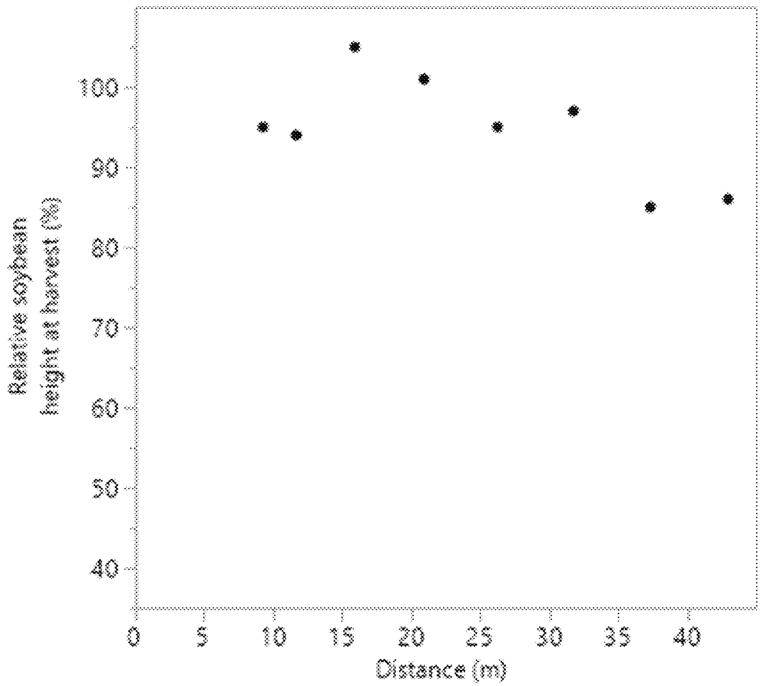
Appendix Figure 12. The relationship between downwind distance and soybean height at maturity for R2 drift events (α= 0.05). Soybean height was converted to a percent of the uninjured. The uninjured was the average height at maturity of 3 random plots with no injury at 28 DAA. Trial 12 was not significant.



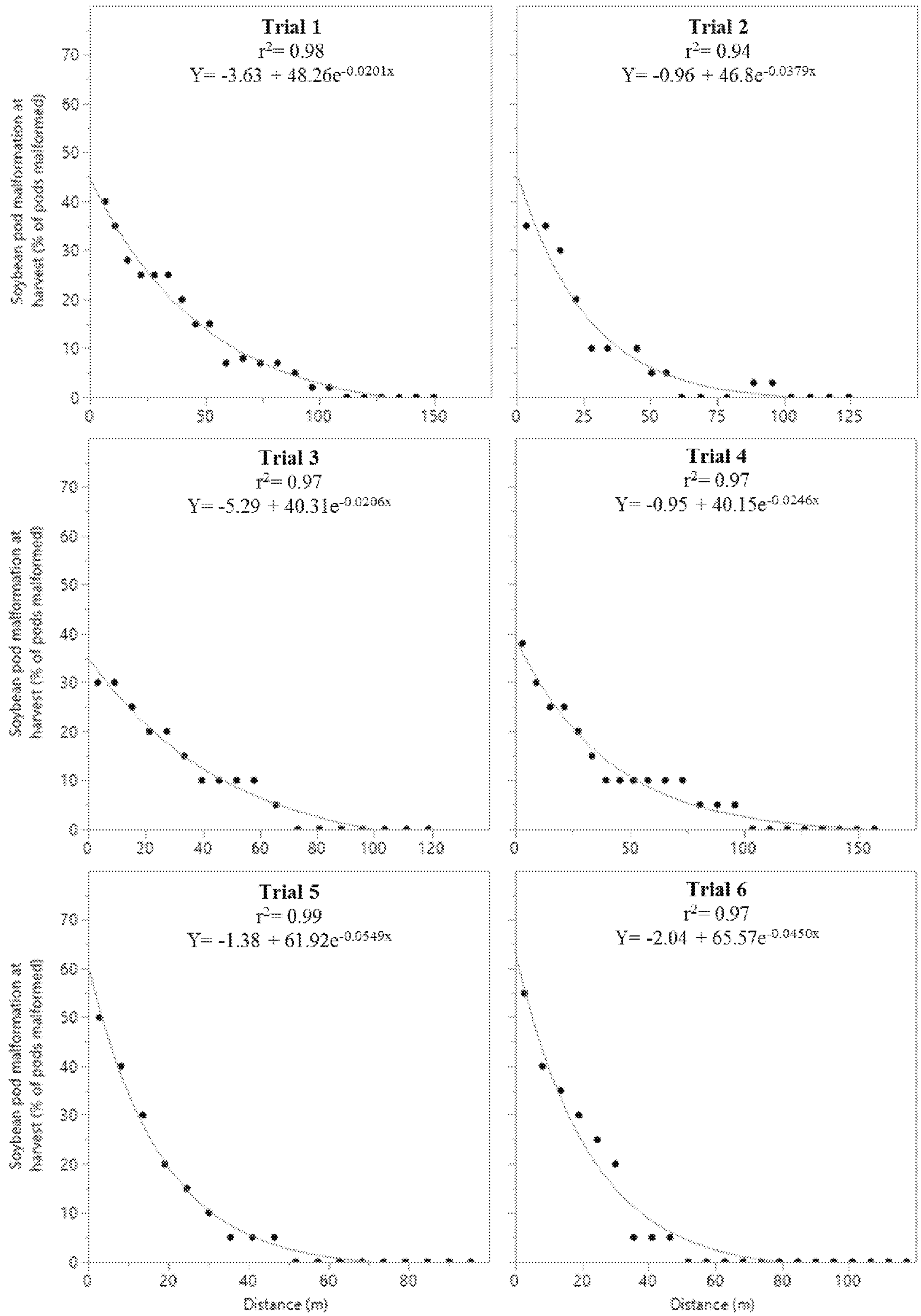
Appendix Figure 13. The relationship between downwind distance and soybean height at maturity for R3 drift events ($\alpha = 0.05$). Soybean height was converted to a percent of the uninjured. The uninjured was the average height at maturity of 3 random plots with no injury at 28 DAA. Trials 14 and 17 were not significant.



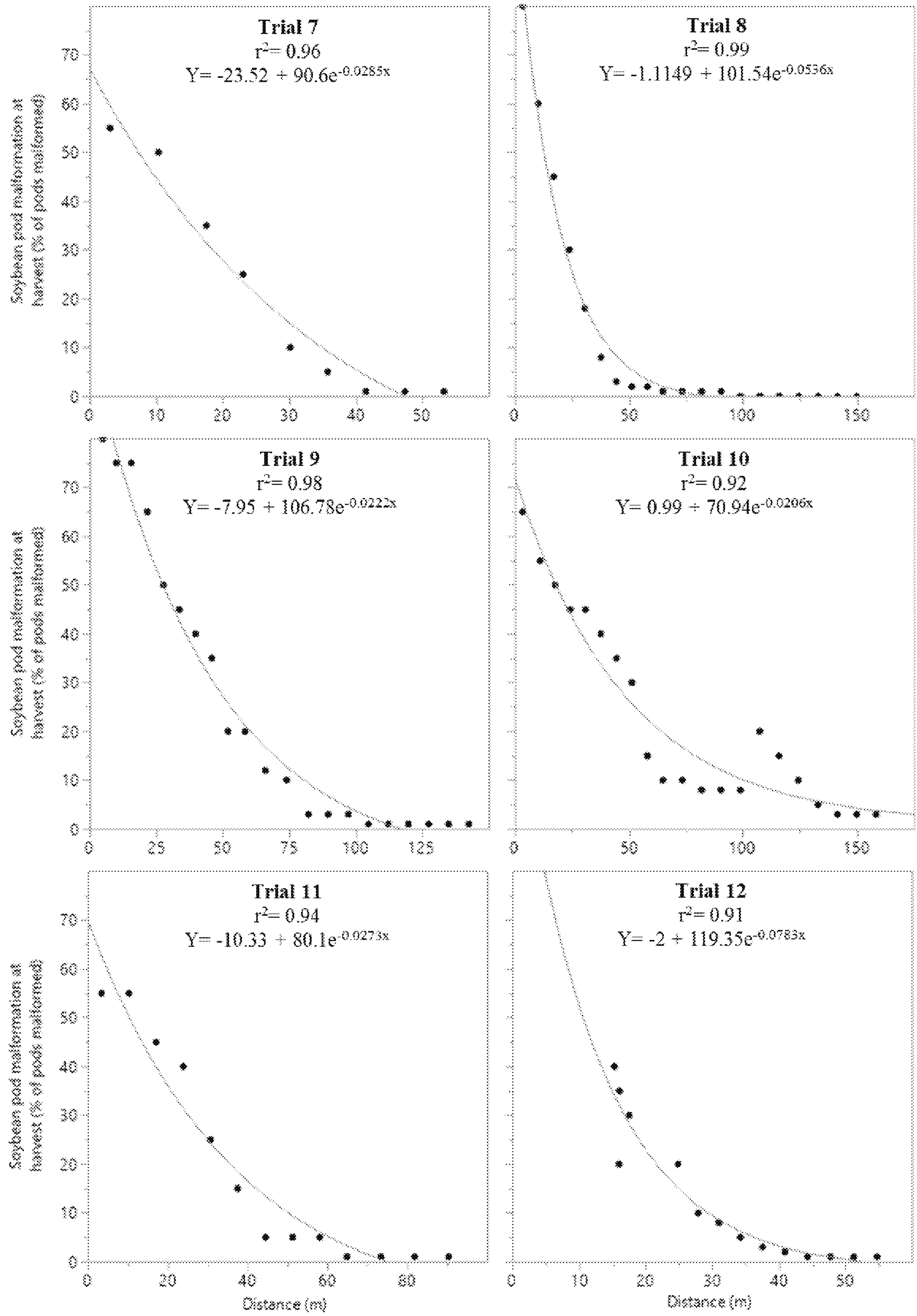
Appendix Figure 14. The relationship between downwind distance and soybean height at maturity for R4 drift events (α= 0.05). Soybean height was converted to a percent of the uninjured. The uninjured was the average height at maturity of 3 random plots with no injury at 28 DAA. Neither trial 18 or 19 were significant.



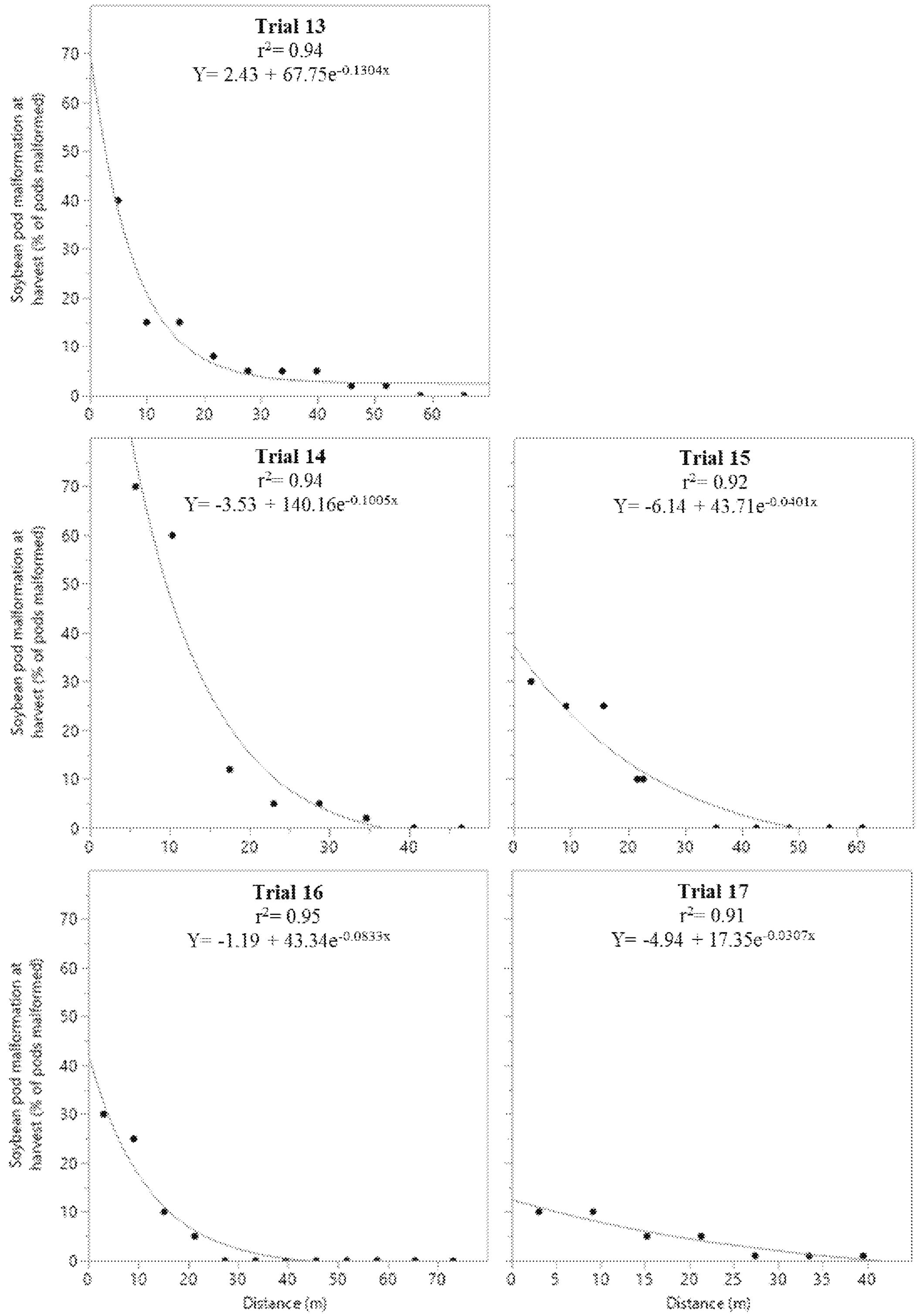
Appendix Figure 15. The relationship between downwind distance and soybean height at harvest for trial 20 (R5) (α= 0.05). Soybean height was converted to a percent of the uninjured. The uninjured was the average harvest height of 3 random plots with no injury at 28 DAA. Trial 20 was not significant.



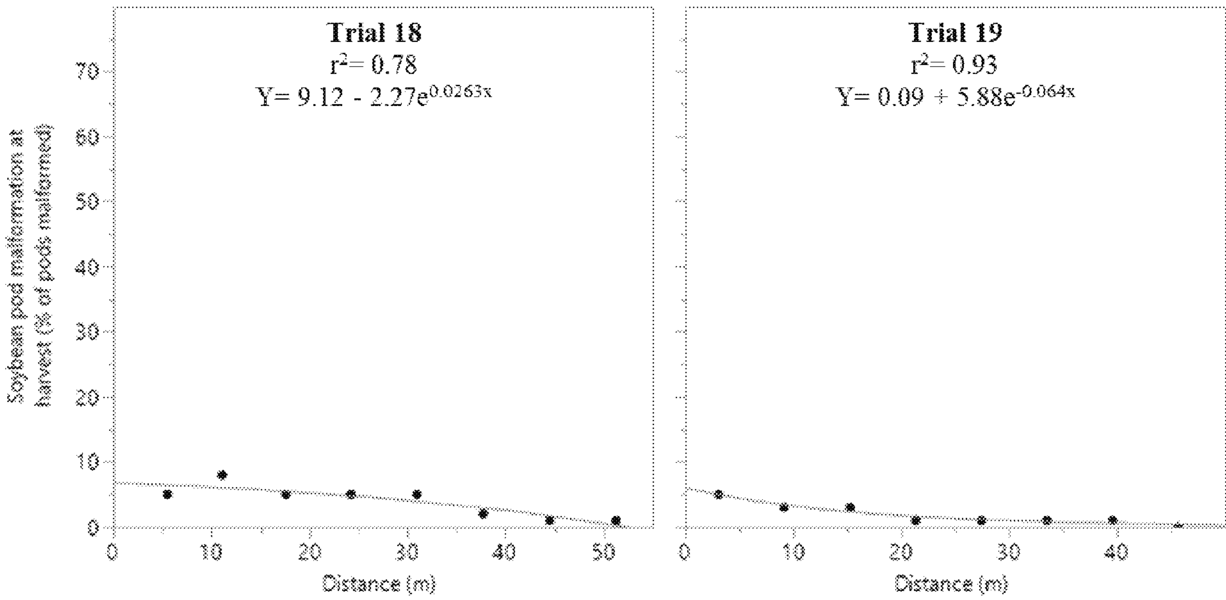
Appendix Figure 16. The relationship between downwind distance and soybean pod malformation at maturity for R1 drift events (α= 0.05). Soybean pod malformation was rated as a percent of the total pods malformed.



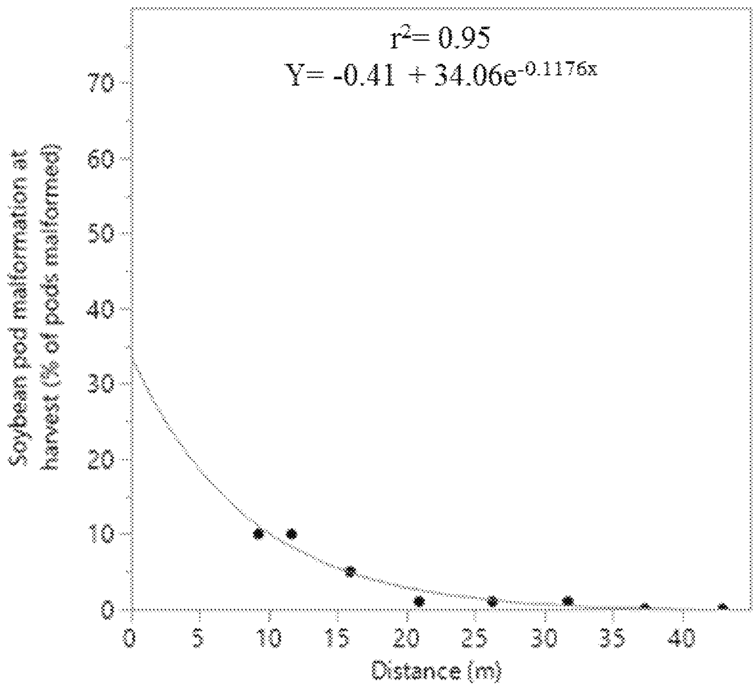
Appendix Figure 17. The relationship between downwind distance and soybean pod malformation at maturity for R2 drift events (α= 0.05). Soybean pod malformation was rated as a percent of the total pods malformed.



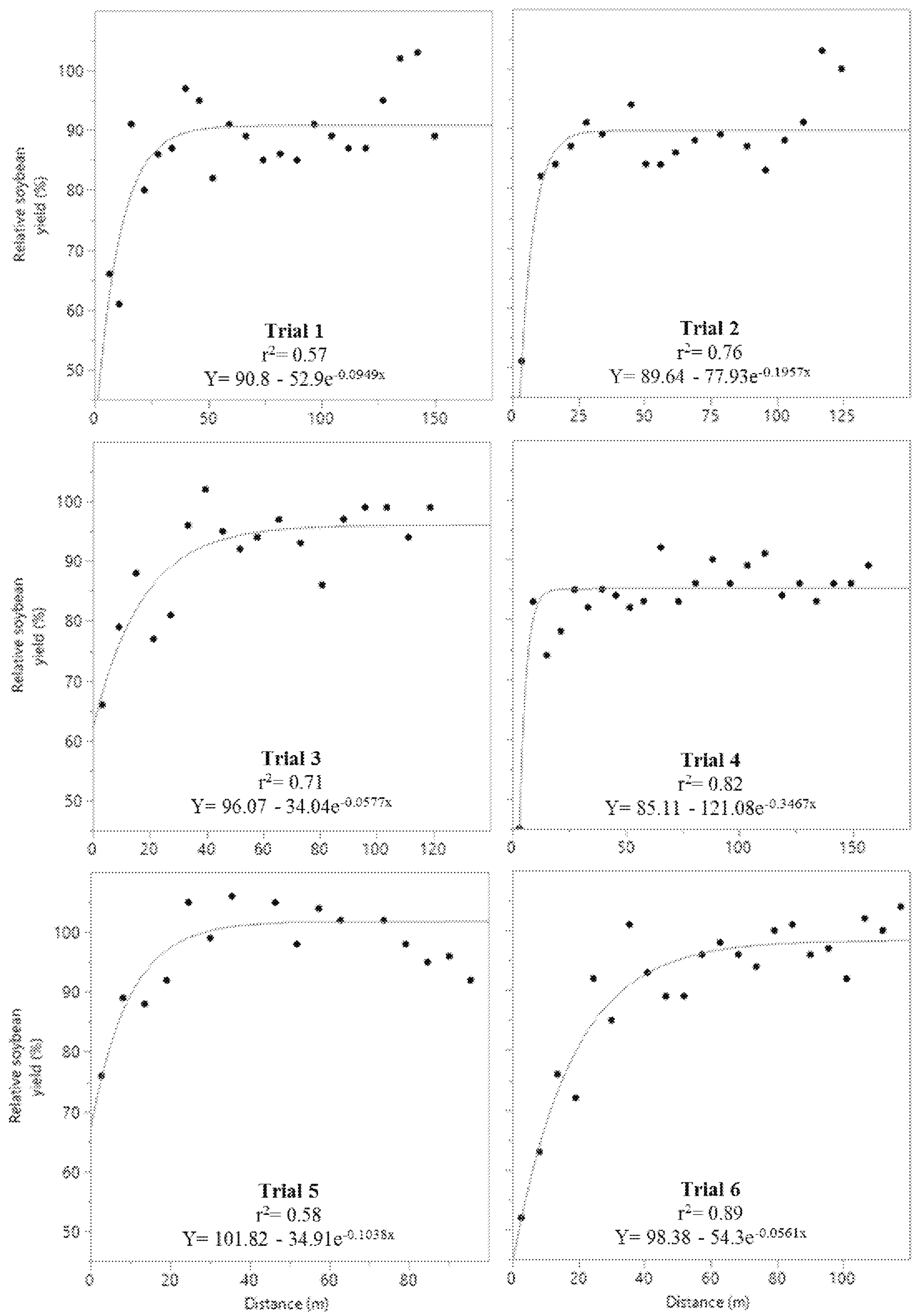
Appendix Figure 18. The relationship between downwind distance and soybean pod malformation at maturity for R3 drift events (α= 0.05). Soybean pod malformation was rated as a percent of the total pods malformed.



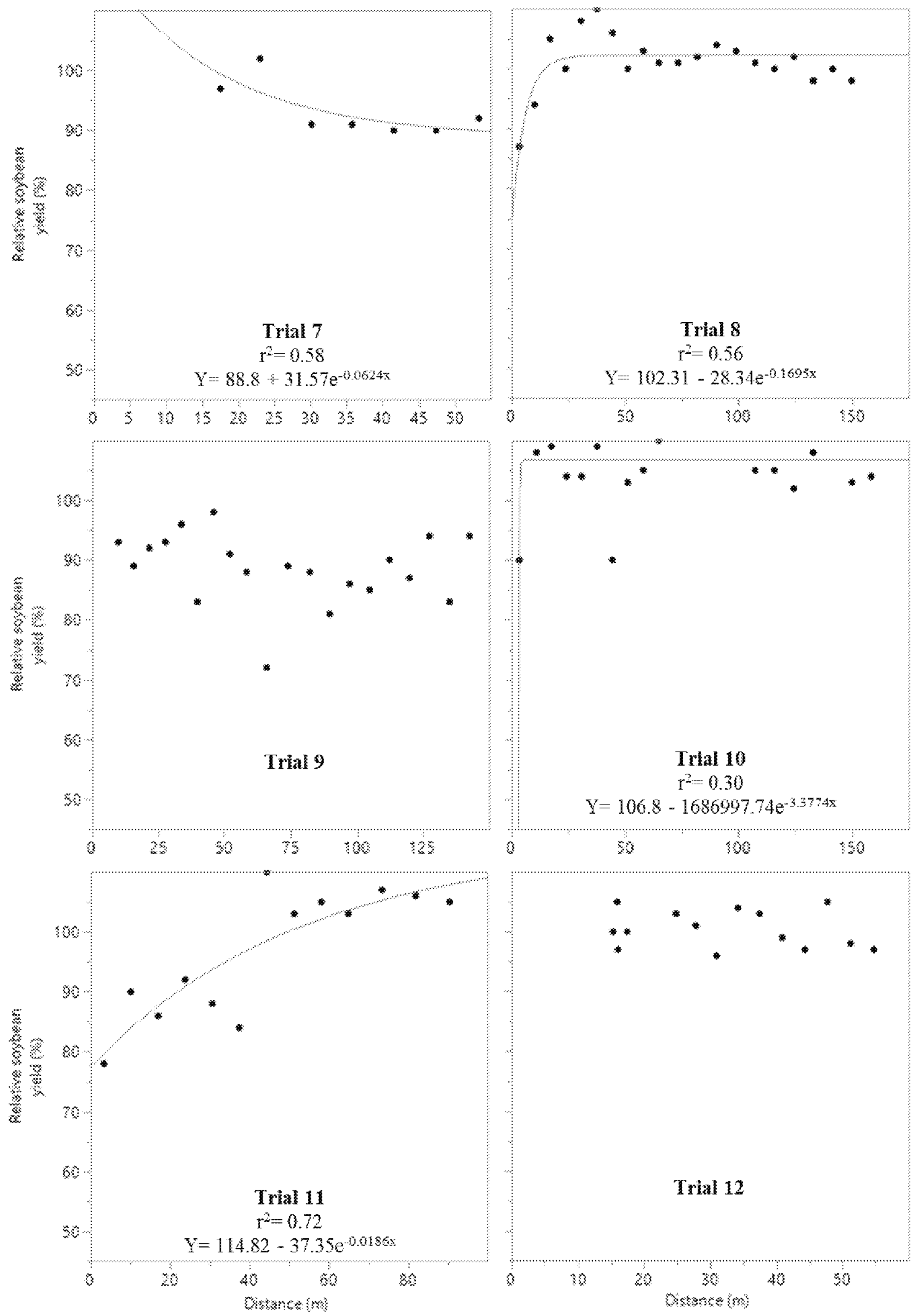
Appendix Figure 19. The relationship between downwind distance and soybean pod malformation at maturity for R4 drift events (α= 0.05). Soybean pod malformation was rated as a percent of the total pods malformed.



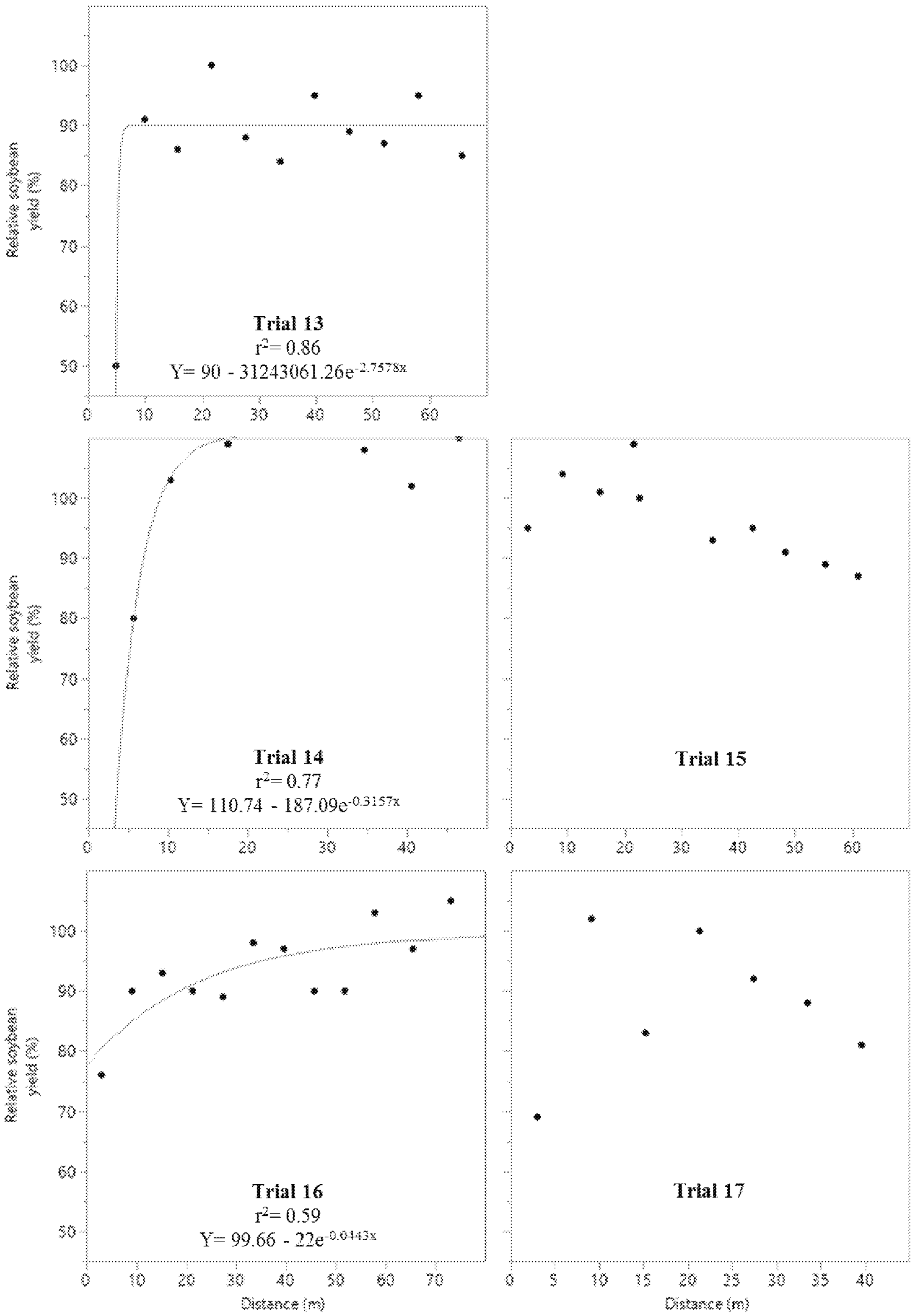
Appendix Figure 20. The relationship between downwind distance and soybean pod malformation for trial 20 (R5) ($\alpha = 0.05$). Soybean pod malformation was rated as a percent of the total pods malformed.



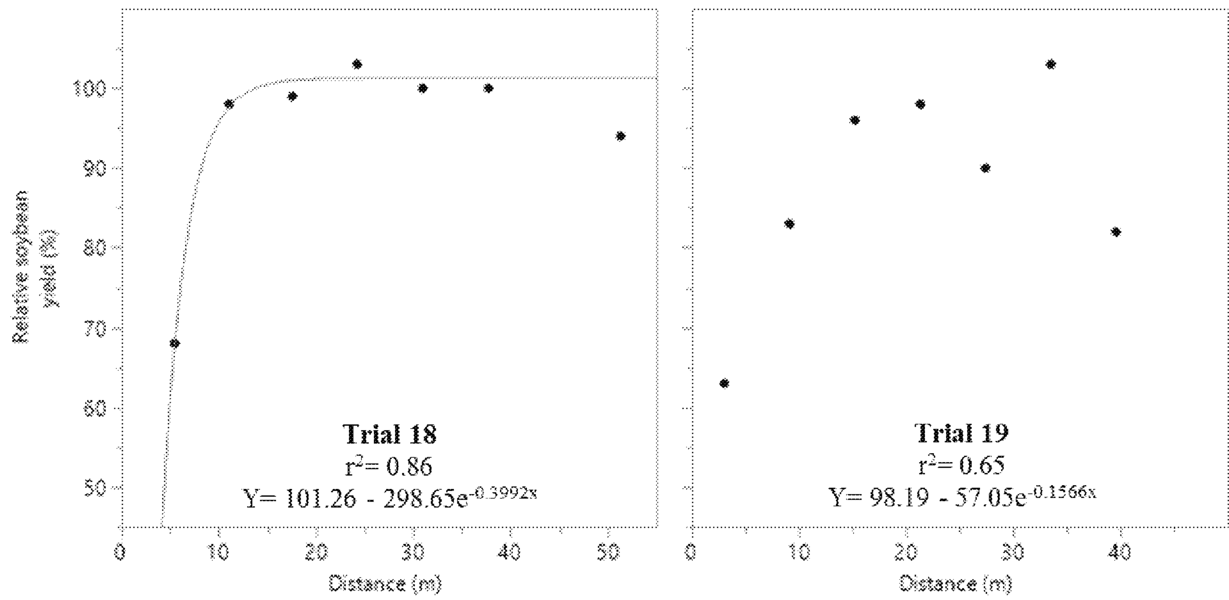
Appendix Figure 21. The relationship between downwind distance and soybean yield for R1 drift events (α= 0.05). Soybean yield was converted to a percent of the uninjured. The uninjured was the average yield of 3 random plots within each trial with no injury at 28 DAA.



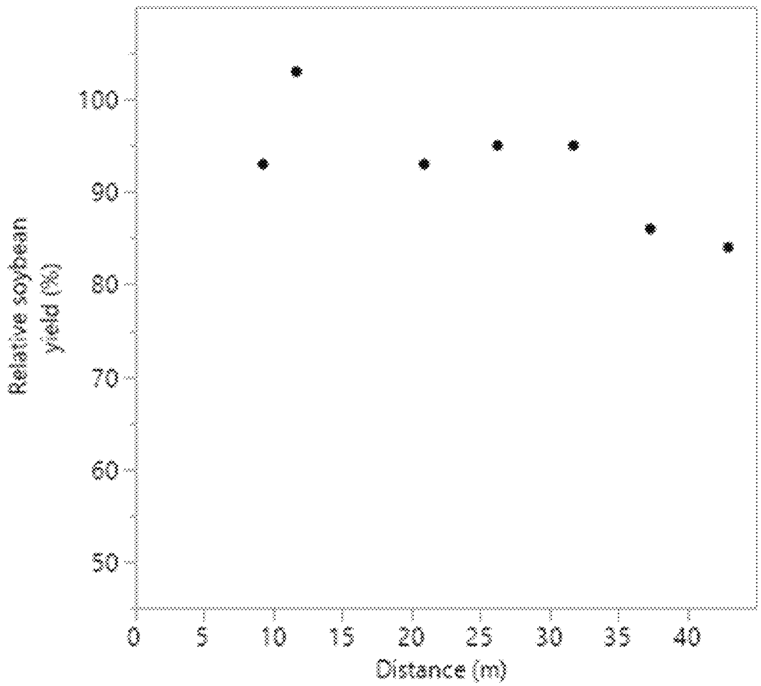
Appendix Figure 22. The relationship between downwind distance and soybean yield for R2 drift events ($\alpha = 0.05$). Soybean yield was converted to a percent of the uninjured. The uninjured was the average yield of 3 random plots within each trial with no injury at 28 DAA. Trials 9 and 12 were not significant.



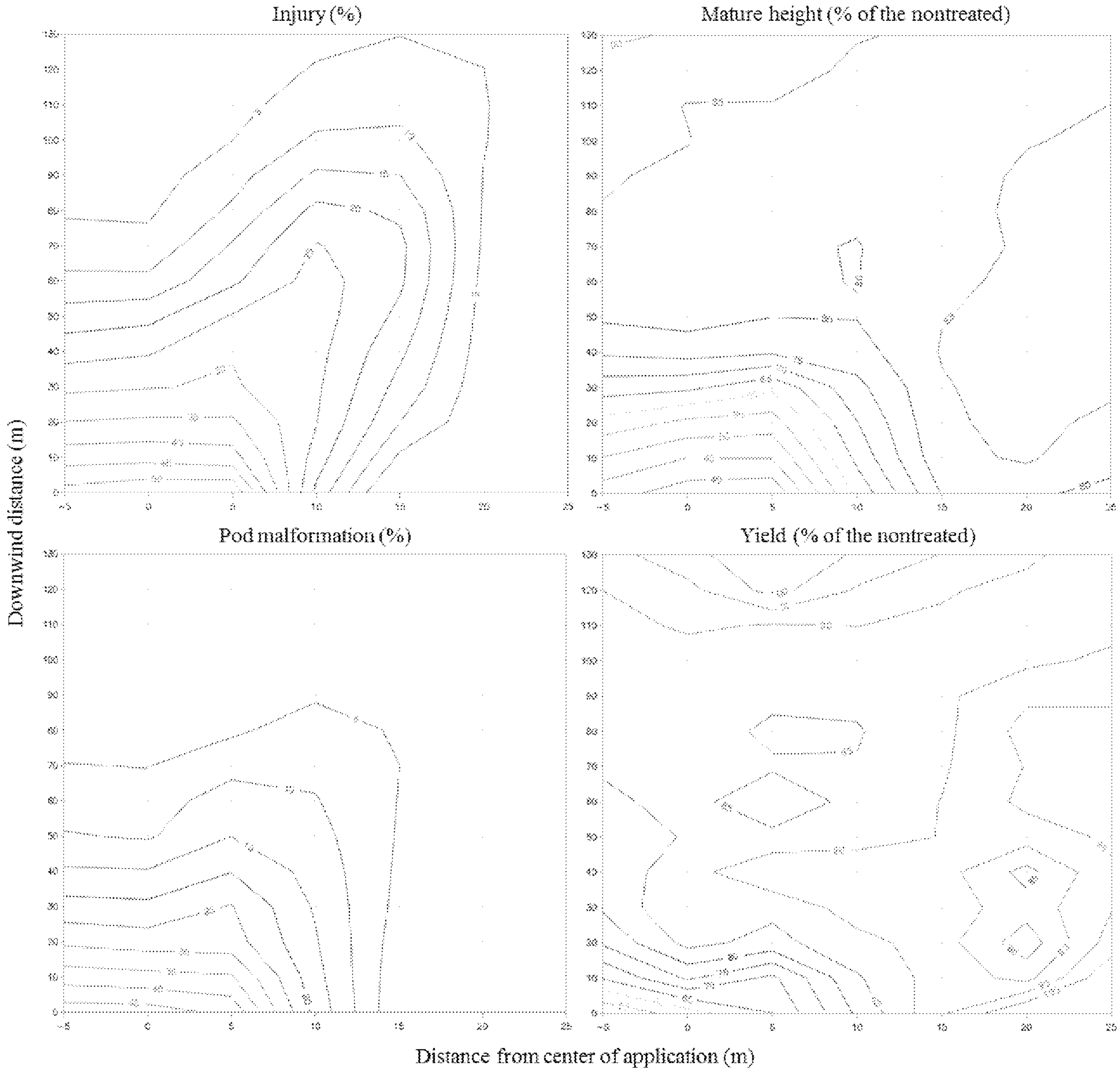
Appendix Figure 23. The relationship between downwind distance and soybean yield for R3 drift events (α= 0.05). Soybean yield was converted to a percent of the uninjured. The uninjured was the average yield of 3 random plots within each trial with no injury at 28 DAA. Trials 15 and 17 were not significant.



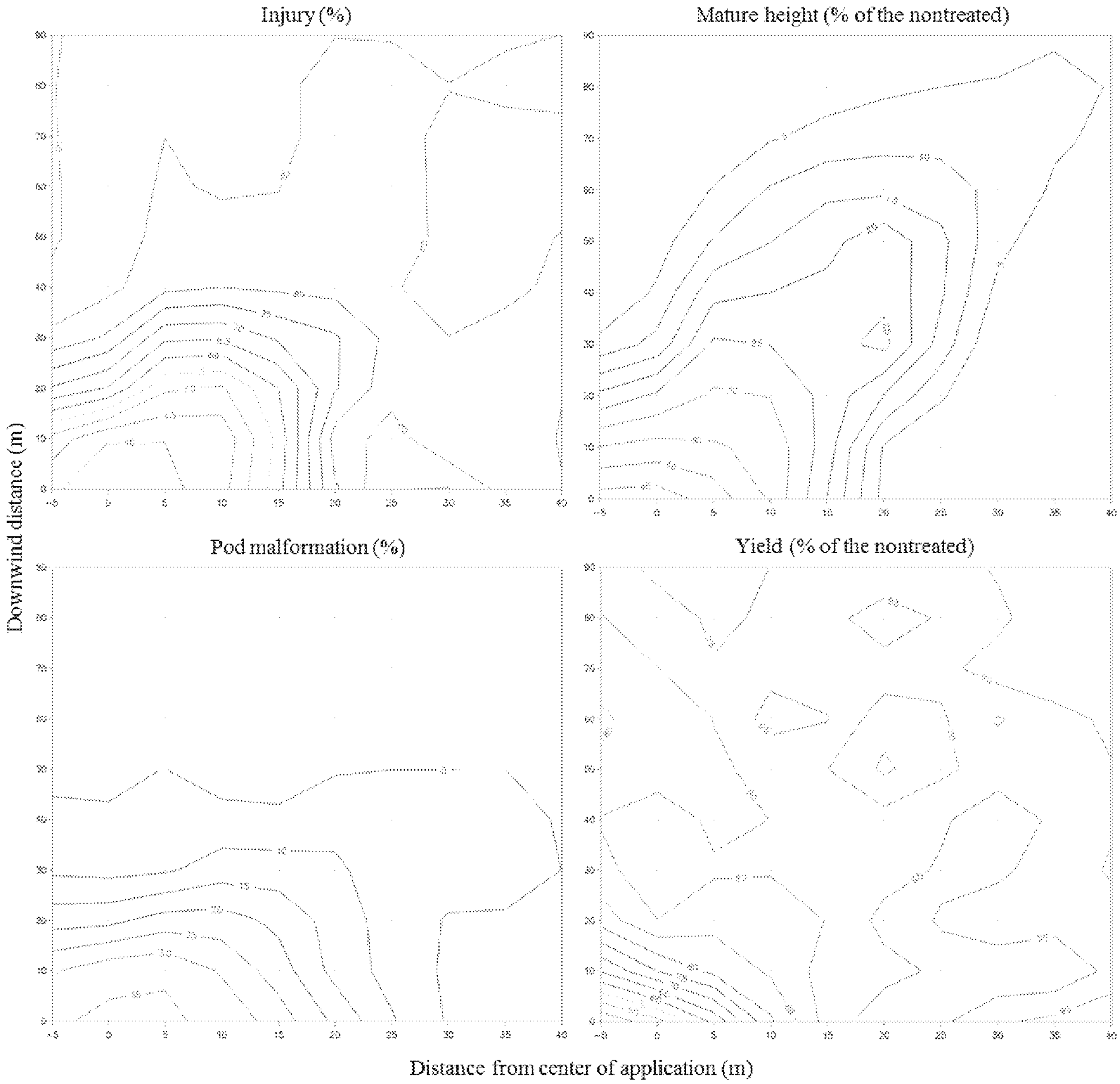
Appendix Figure 24. The relationship between downwind distance and soybean yield for R4 drift events ($\alpha = 0.05$). Soybean yield was converted to a percent of the uninjured. The uninjured was the average yield of 3 random plots within each trial with no injury at 28 DAA. Trial 19 was not significant.



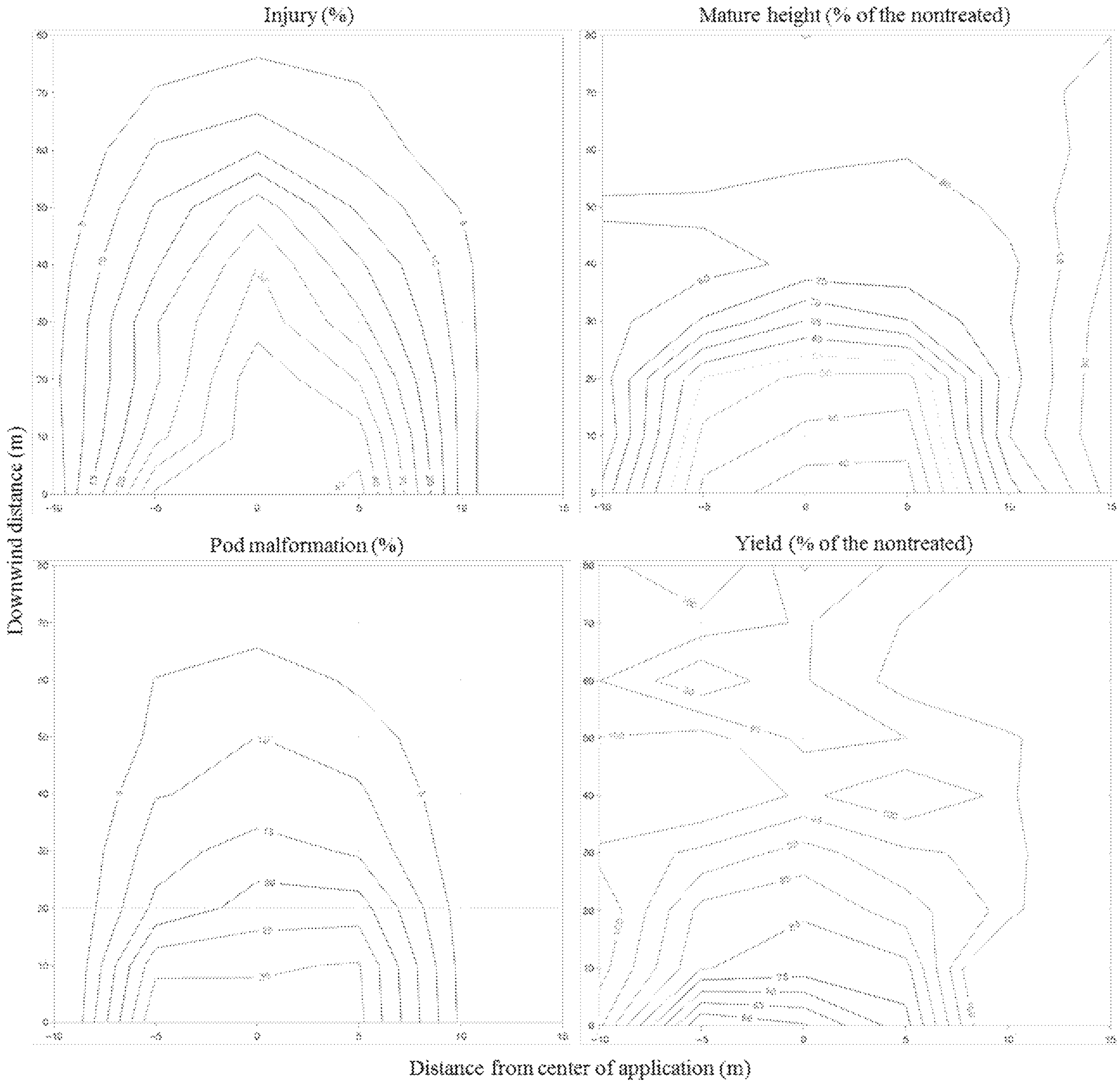
Appendix Figure 25. The relationship between downwind distance and soybean yield for trial 20 (R5) (α= 0.05). Soybean yield was converted to a percent of the uninjured. The uninjured was the average yield of 3 random plots within each trial with no injury at 28 DAA. Trial 20 was not significant.



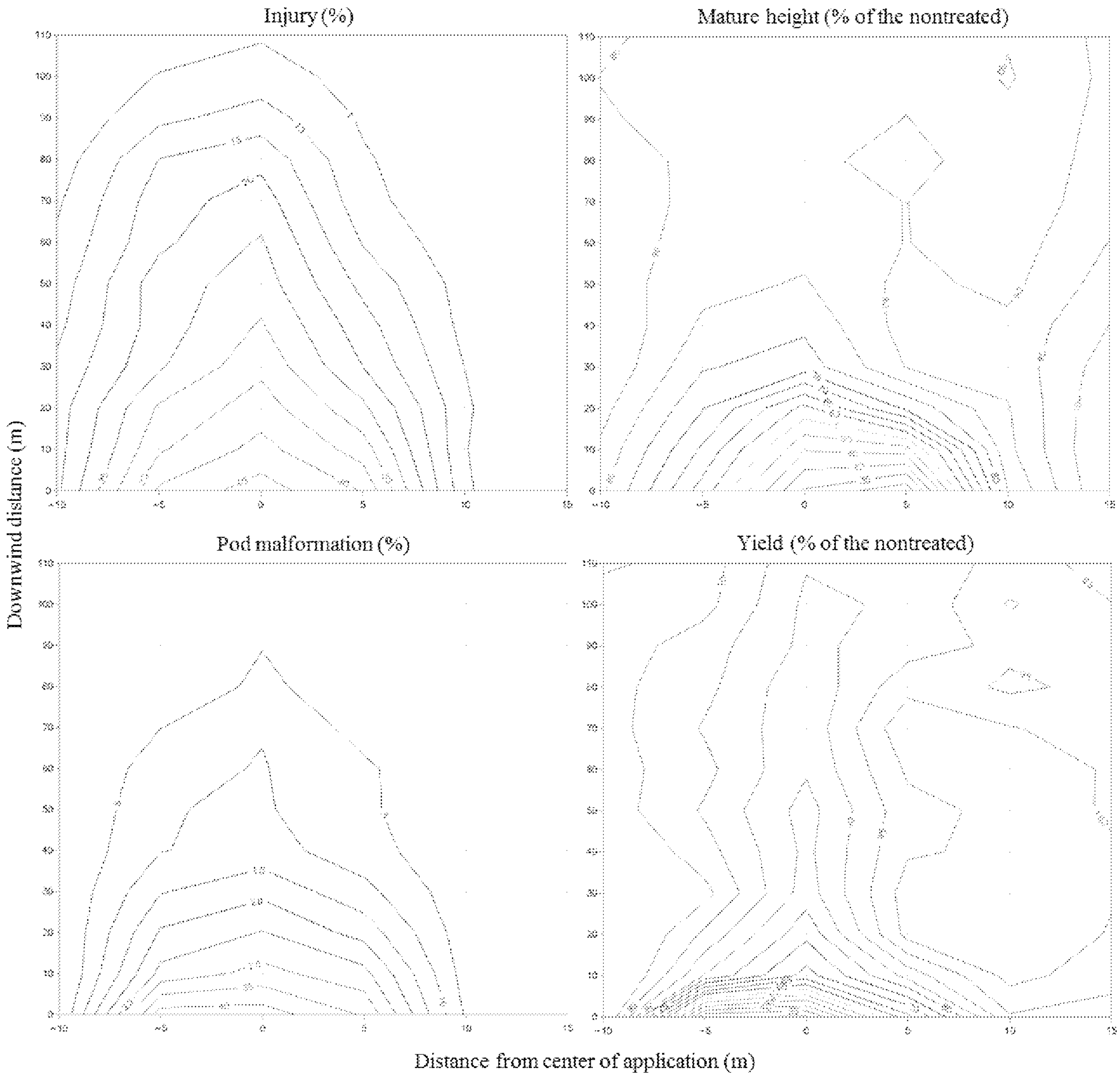
Appendix figure 26. Contour maps illustrating soybean injury, mature height, pod malformation, and yield for trial 1. Soybean injury was rated on a scale from 0 to 100% with 0% being no injury and 100% being plant death. Pod malformation is presented as a percent of total pods malformed. The untreated is the average mature height or yield of 3 random plots within the trial (but outside the drift plume) observed to have no injury at 28 days after application (DAA).



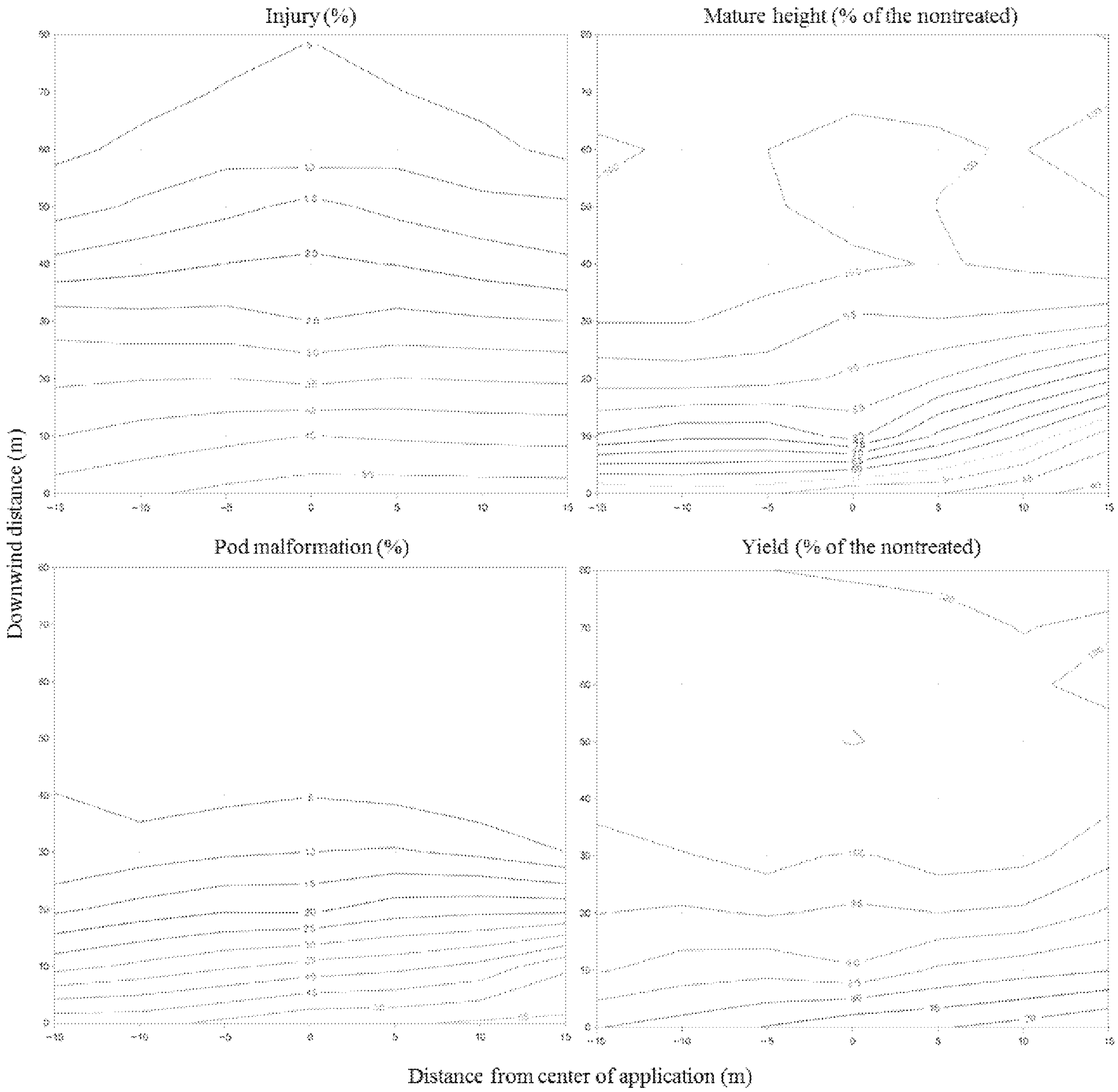
Appendix figure 27. Contour maps illustrating soybean injury, mature height, pod malformation, and yield for trial 2. Soybean injury was rated on a scale from 0 to 100% with 0% being no injury and 100% being plant death. Pod malformation is presented as a percent of total pods malformed. The untreated is the average mature height or yield of 3 random plots within the trial (but outside the drift plume) observed to have no injury at 28 days after application (DAA).



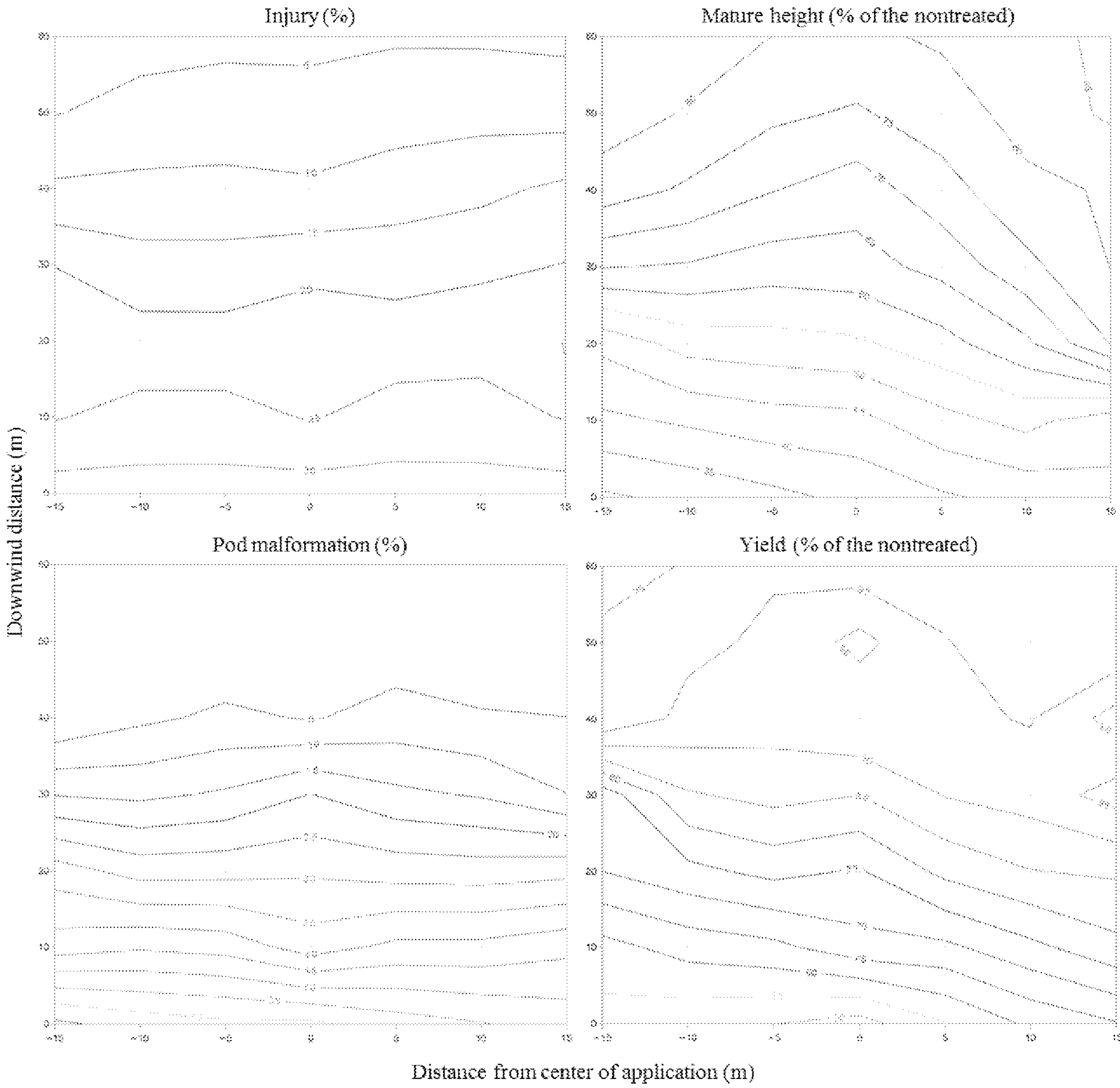
Appendix figure 28. Contour maps illustrating soybean injury, mature height, pod malformation, and yield for trial 3. Soybean injury was rated on a scale from 0 to 100% with 0% being no injury and 100% being plant death. Pod malformation is presented as a percent of total pods malformed. The untreated is the average mature height or yield of 3 random plots within the trial (but outside the drift plume) observed to have no injury at 28 days after application (DAA).



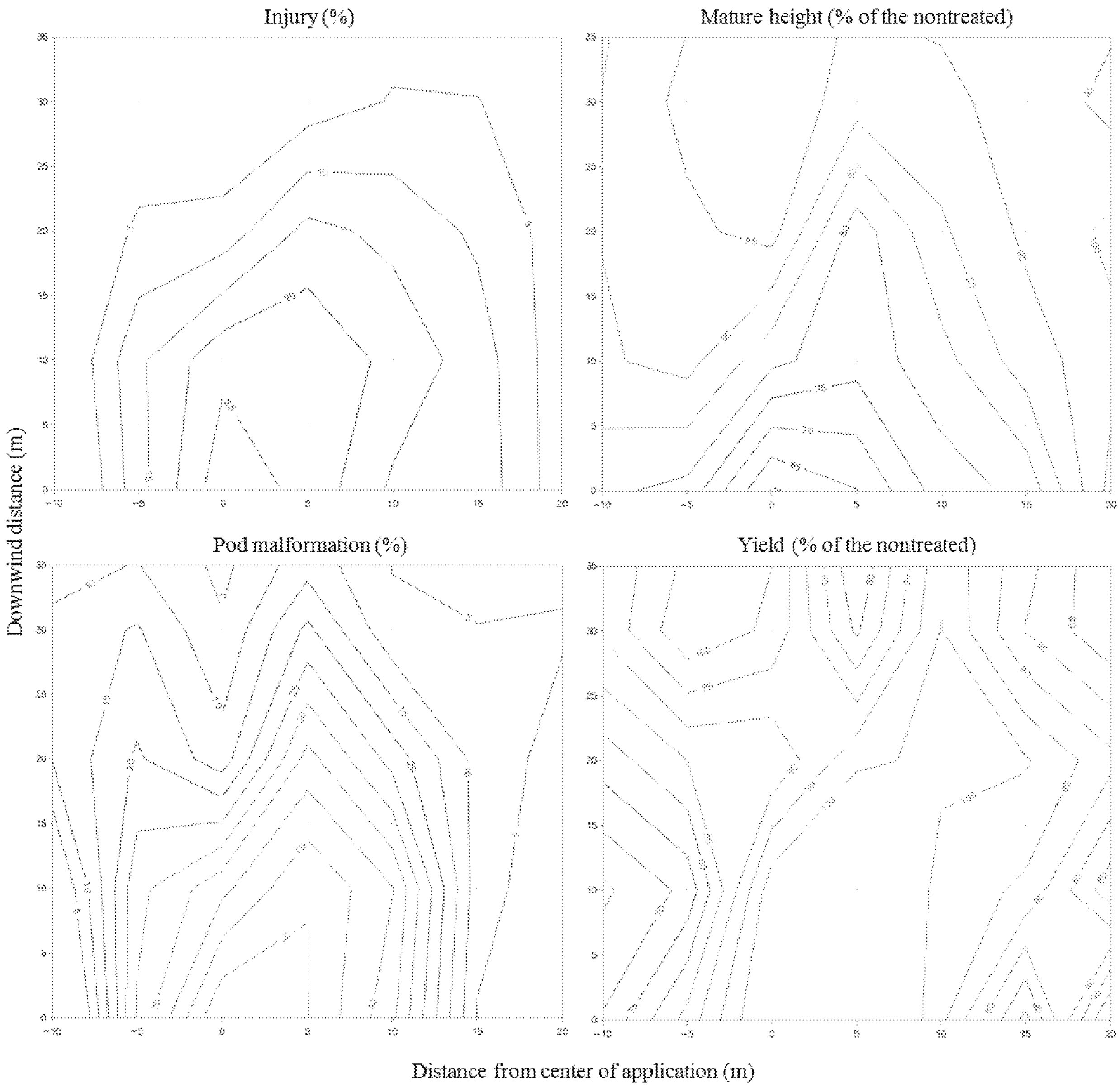
Appendix figure 29. Contour maps illustrating soybean injury, mature height, pod malformation, and yield for trial 4. Soybean injury was rated on a scale from 0 to 100% with 0% being no injury and 100% being plant death. Pod malformation is presented as a percent of total pods malformed. The untreated is the average mature height or yield of 3 random plots within the trial (but outside the drift plume) observed to have no injury at 28 days after application (DAA).



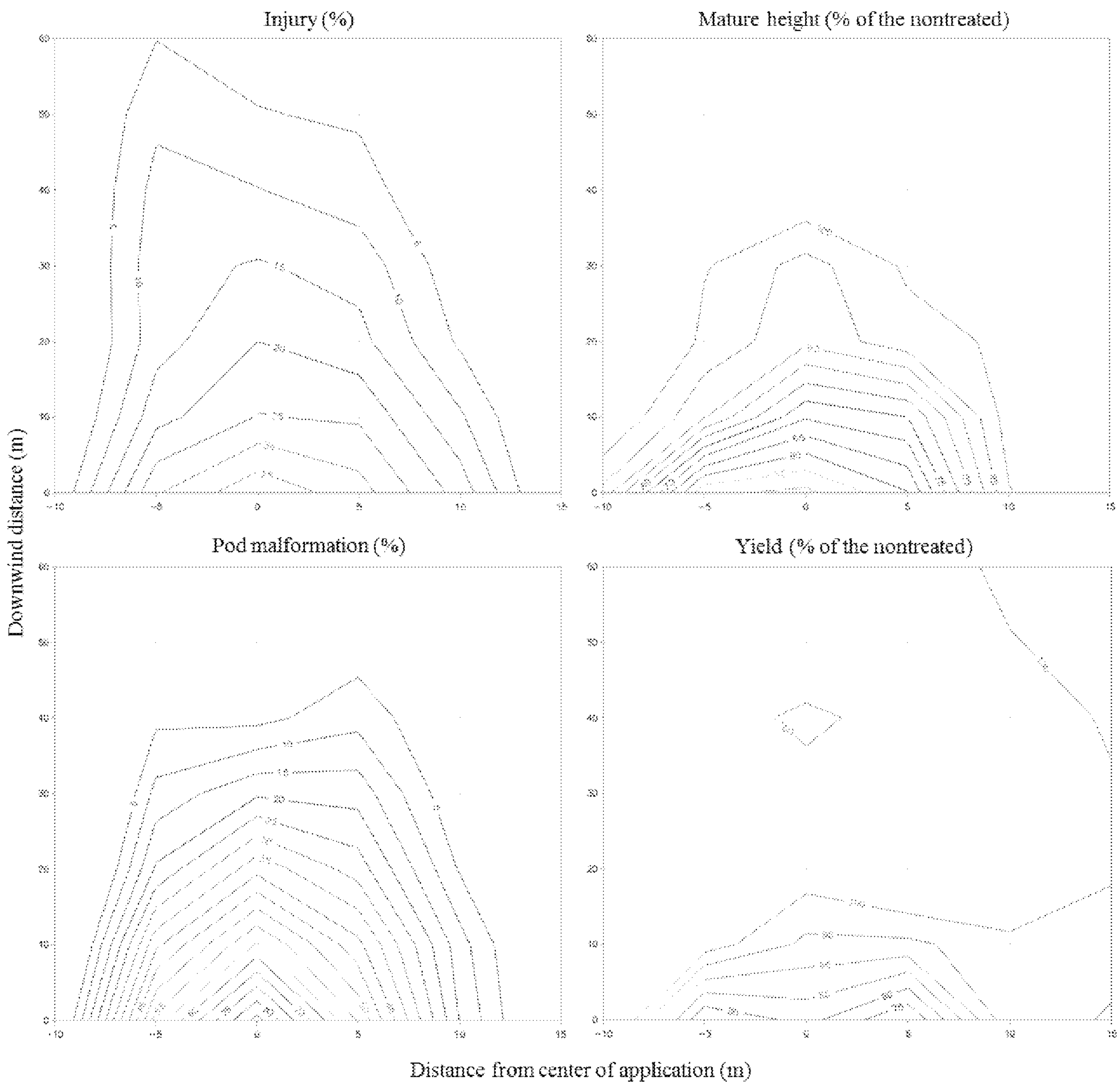
Appendix figure 30. Contour maps illustrating soybean injury, mature height, pod malformation, and yield for trial 5. Soybean injury was rated on a scale from 0 to 100% with 0% being no injury and 100% being plant death. Pod malformation is presented as a percent of total pods malformed. The untreated is the average mature height or yield of 3 random plots within the trial (but outside the drift plume) observed to have no injury at 28 days after application (DAA).



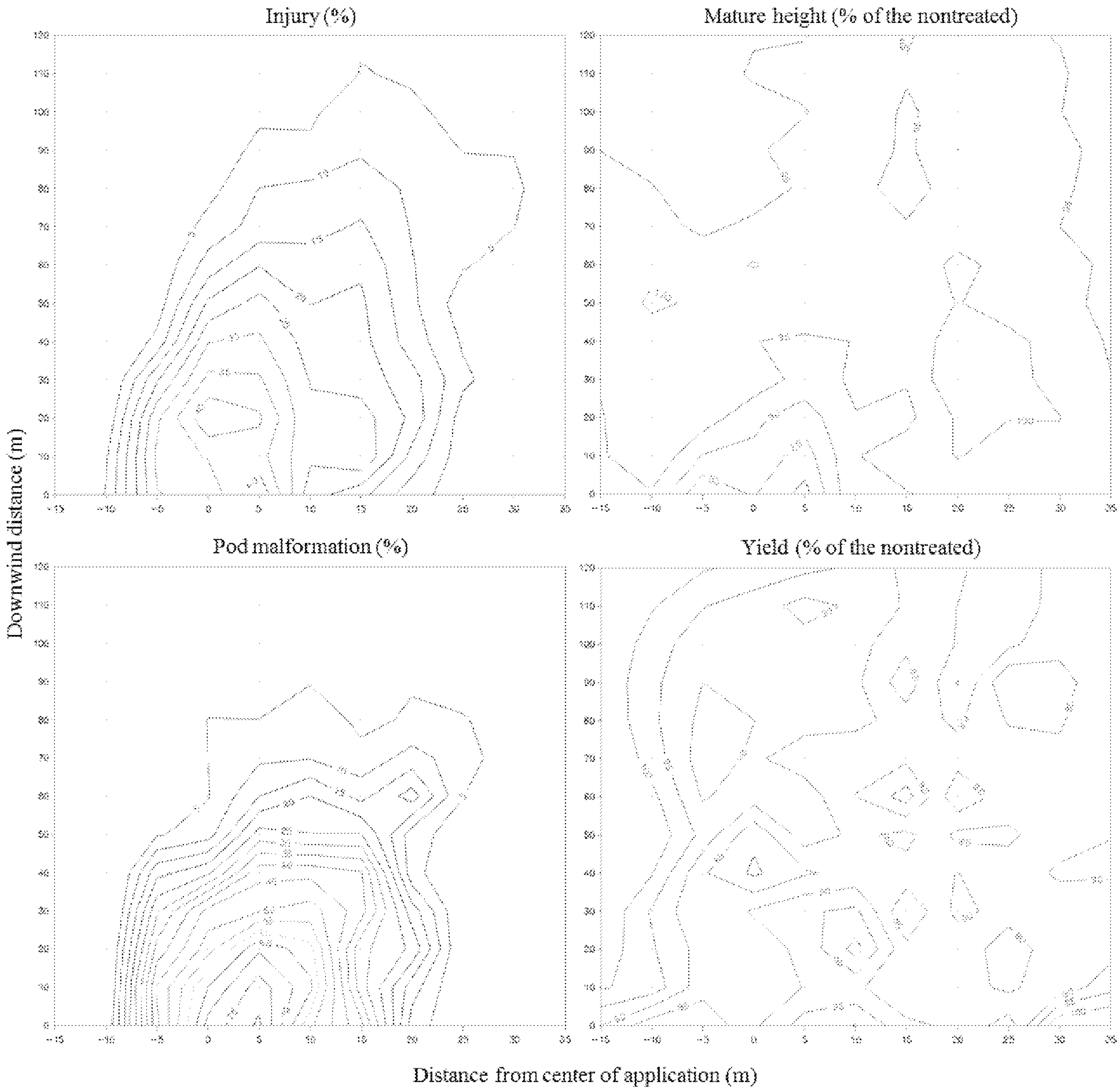
Appendix figure 31. Contour maps illustrating soybean injury, mature height, pod malformation, and yield for trial 6. Soybean injury was rated on a scale from 0 to 100% with 0% being no injury and 100% being plant death. Pod malformation is presented as a percent of total pods malformed. The untreated is the average mature height or yield of 3 random plots within the trial (but outside the drift plume) observed to have no injury at 28 days after application (DAA).



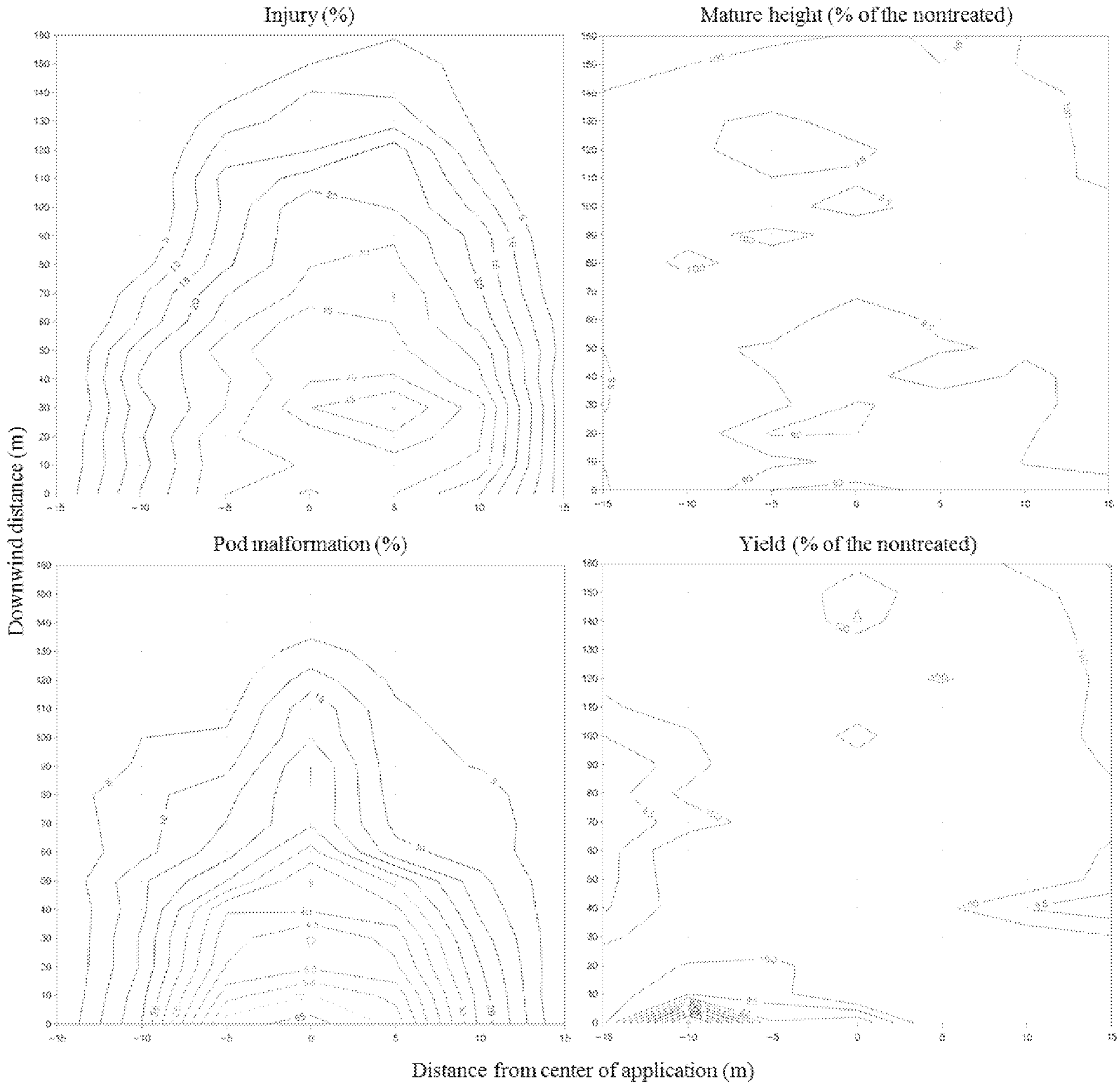
Appendix figure 32. Contour maps illustrating soybean injury, mature height, pod malformation, and yield for trial 7. Soybean injury was rated on a scale from 0 to 100% with 0% being no injury and 100% being plant death. Pod malformation is presented as a percent of total pods malformed. The untreated is the average mature height or yield of 3 random plots within the trial (but outside the drift plume) observed to have no injury at 28 days after application (DAA).



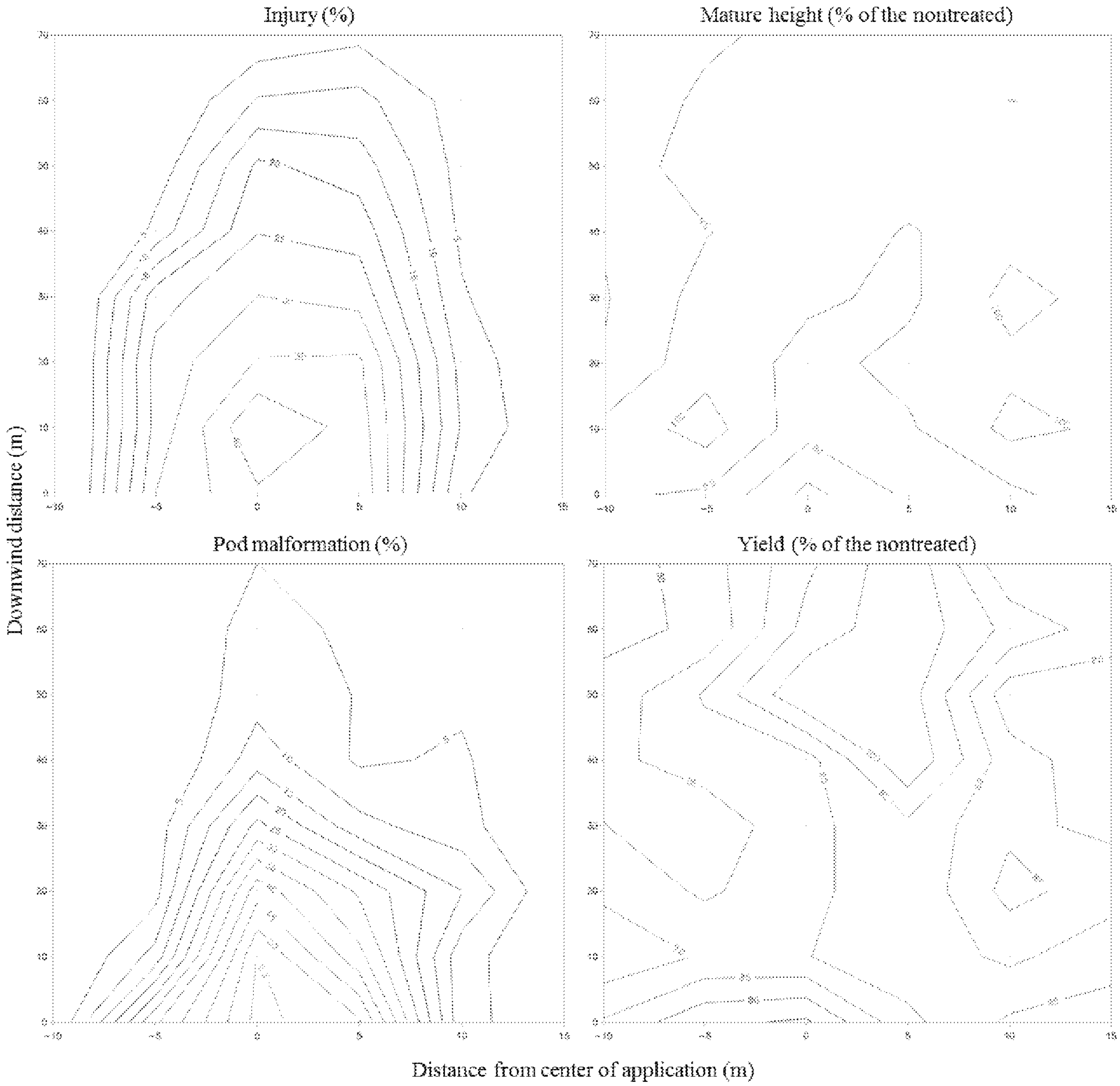
Appendix figure 33. Contour maps illustrating soybean injury, mature height, pod malformation, and yield for trial 8. Soybean injury was rated on a scale from 0 to 100% with 0% being no injury and 100% being plant death. Pod malformation is presented as a percent of total pods malformed. The untreated is the average mature height or yield of 3 random plots within the trial (but outside the drift plume) observed to have no injury at 28 days after application (DAA).



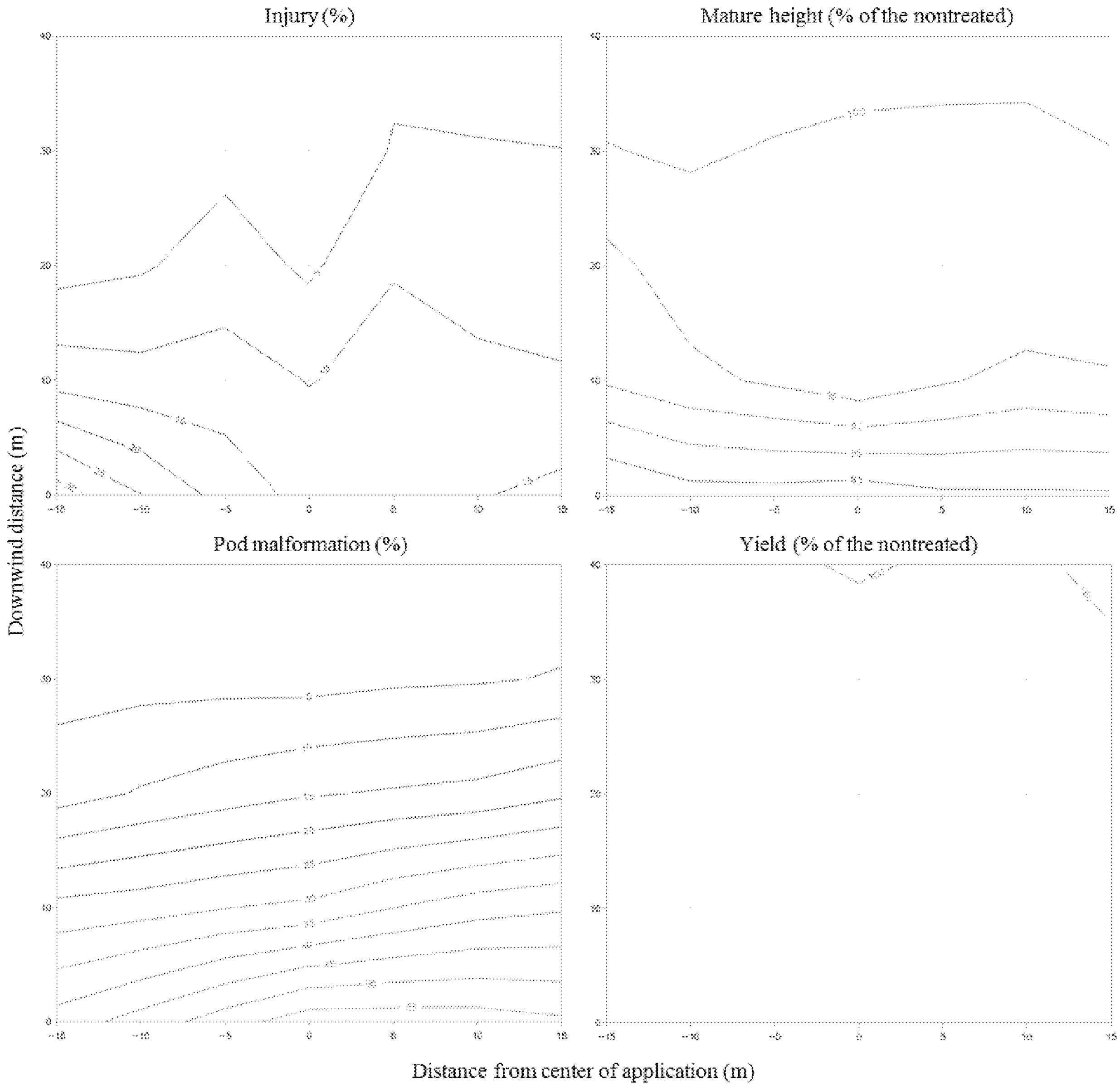
Appendix figure 34. Contour maps illustrating soybean injury, mature height, pod malformation, and yield for trial 9. Soybean injury was rated on a scale from 0 to 100% with 0% being no injury and 100% being plant death. Pod malformation is presented as a percent of total pods malformed. The untreated is the average mature height or yield of 3 random plots within the trial (but outside the drift plume) observed to have no injury at 28 days after application (DAA).



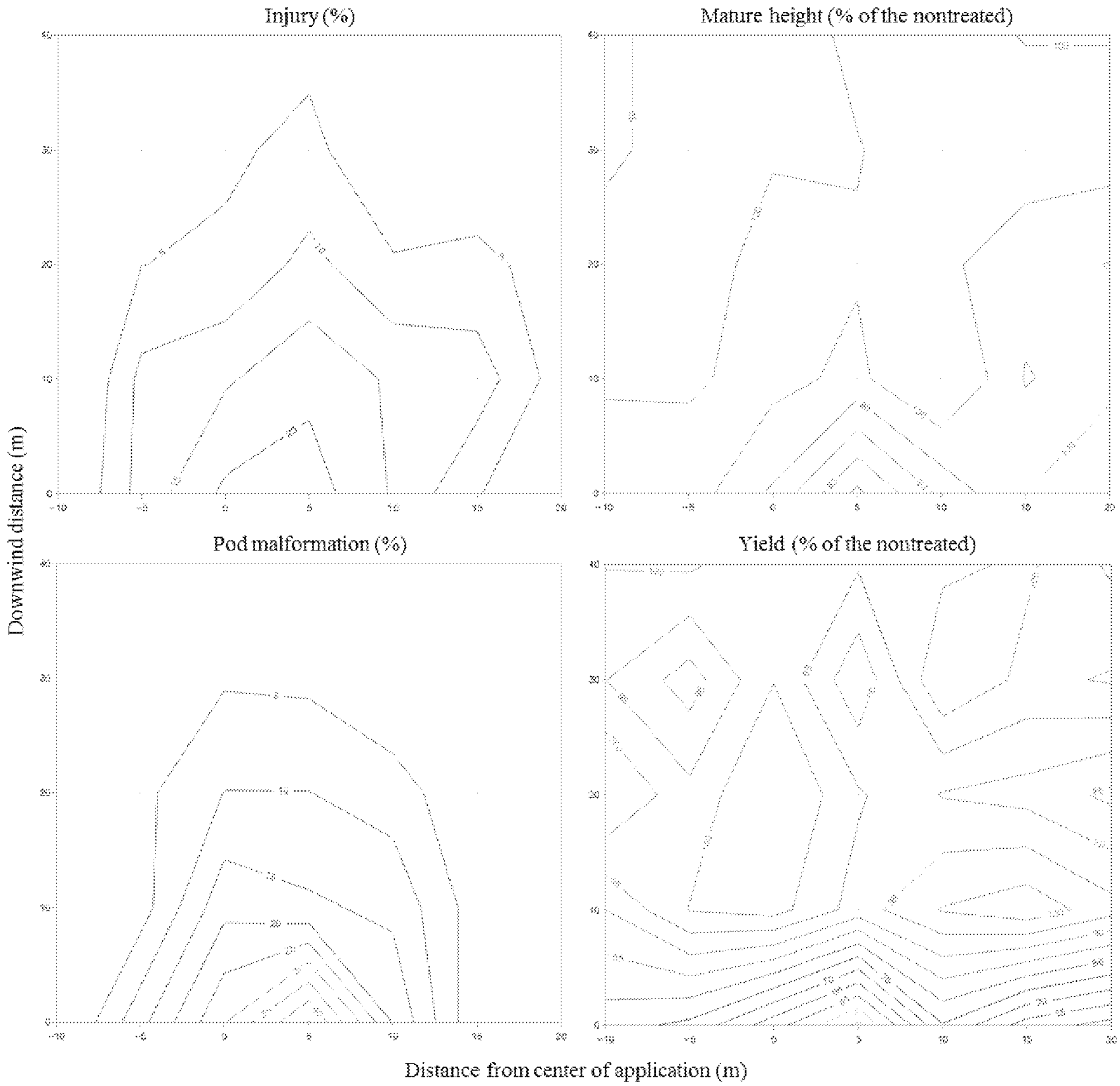
Appendix figure 35. Contour maps illustrating soybean injury, mature height, pod malformation, and yield for trial 10. Soybean injury was rated on a scale from 0 to 100% with 0% being no injury and 100% being plant death. Pod malformation is presented as a percent of total pods malformed. The untreated is the average mature height or yield of 3 random plots within the trial (but outside the drift plume) observed to have no injury at 28 days after application (DAA).



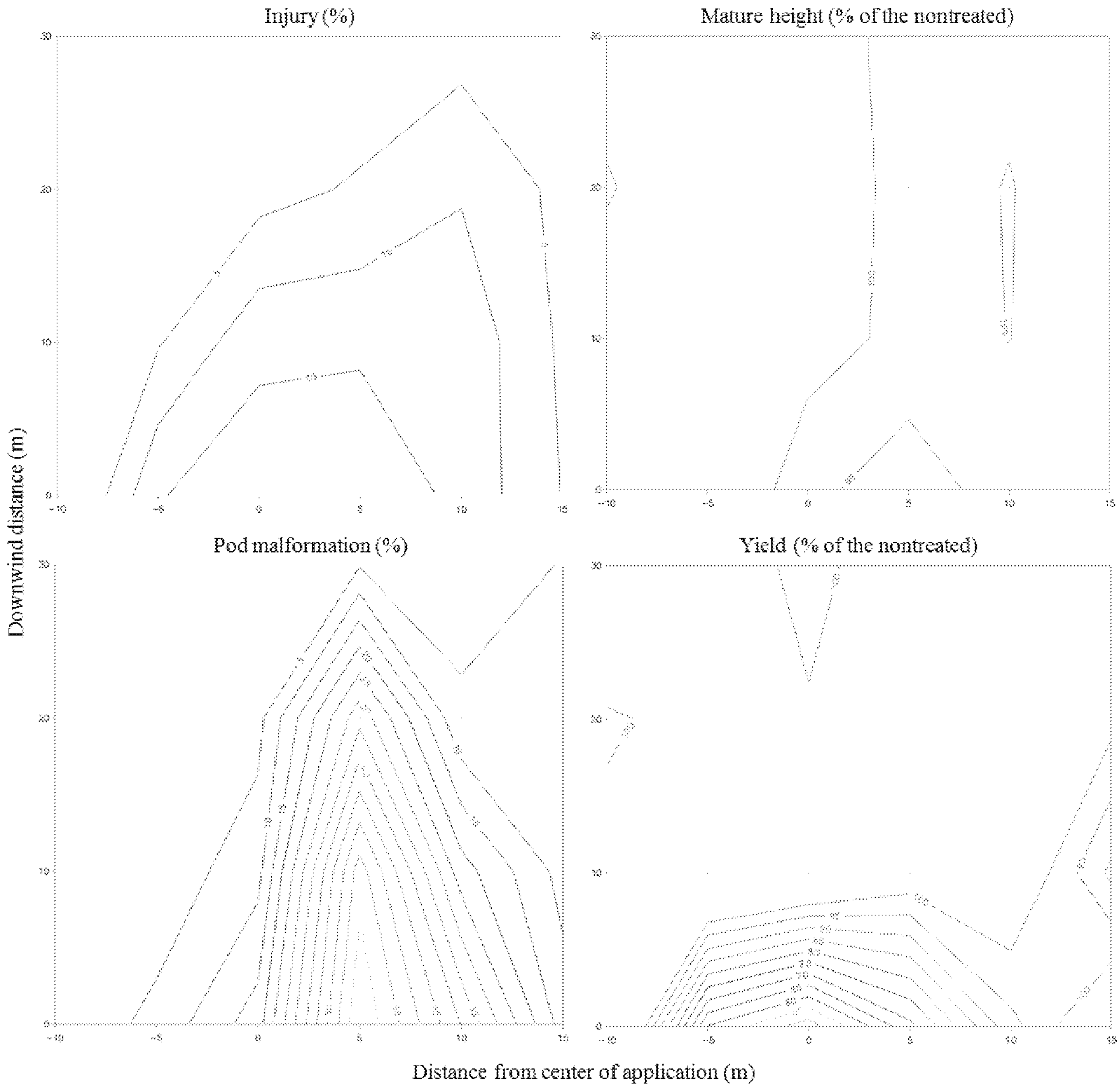
Appendix figure 36. Contour maps illustrating soybean injury, mature height, pod malformation, and yield for trial 11. Soybean injury was rated on a scale from 0 to 100% with 0% being no injury and 100% being plant death. Pod malformation is presented as a percent of total pods malformed. The untreated is the average mature height or yield of 3 random plots within the trial (but outside the drift plume) observed to have no injury at 28 days after application (DAA).



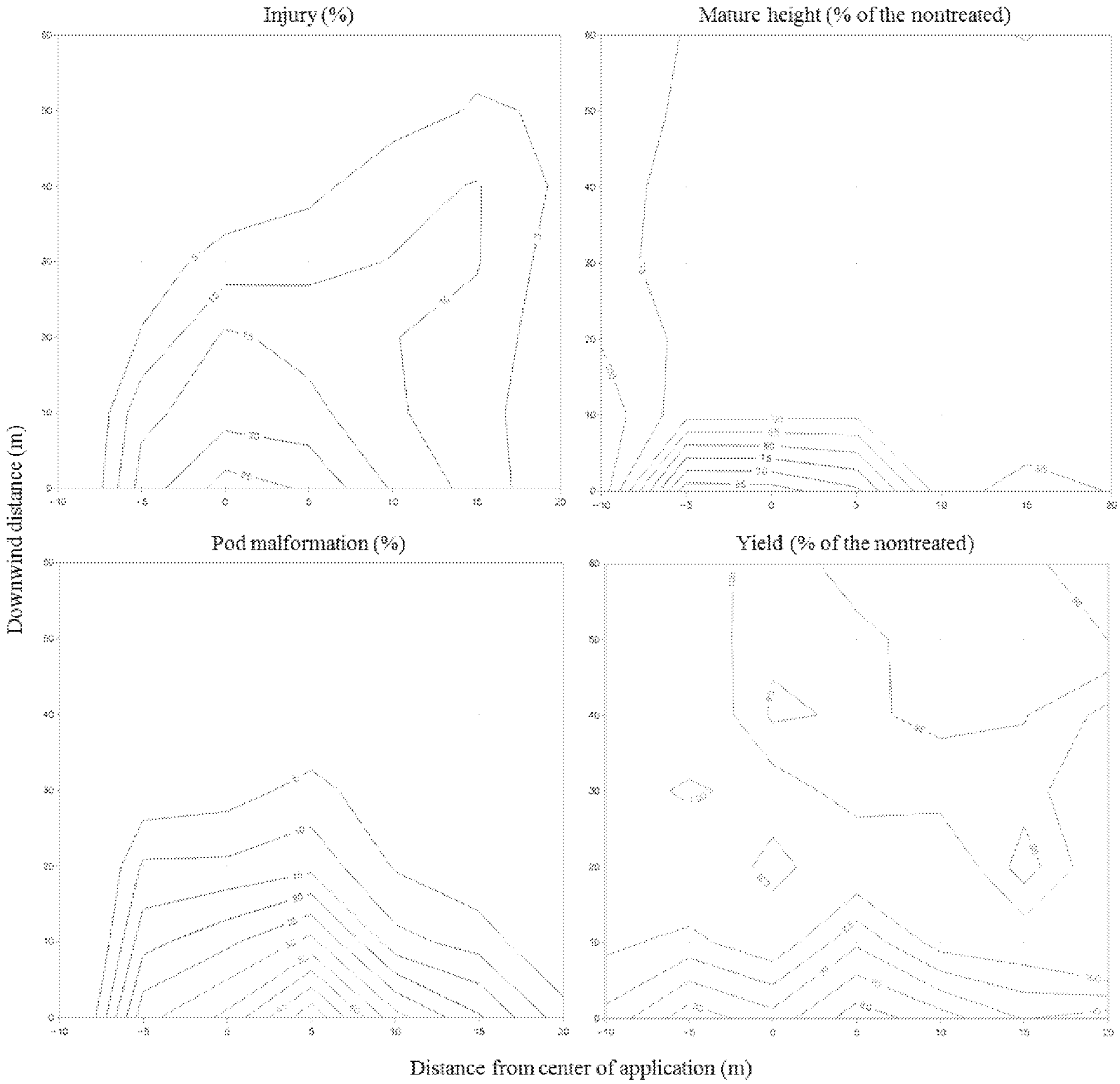
Appendix figure 37. Contour maps illustrating soybean injury, mature height, pod malformation, and yield for trial 12. Soybean injury was rated on a scale from 0 to 100% with 0% being no injury and 100% being plant death. Pod malformation is presented as a percent of total pods malformed. The untreated is the average mature height or yield of 3 random plots within the trial (but outside the drift plume) observed to have no injury at 28 days after application (DAA).



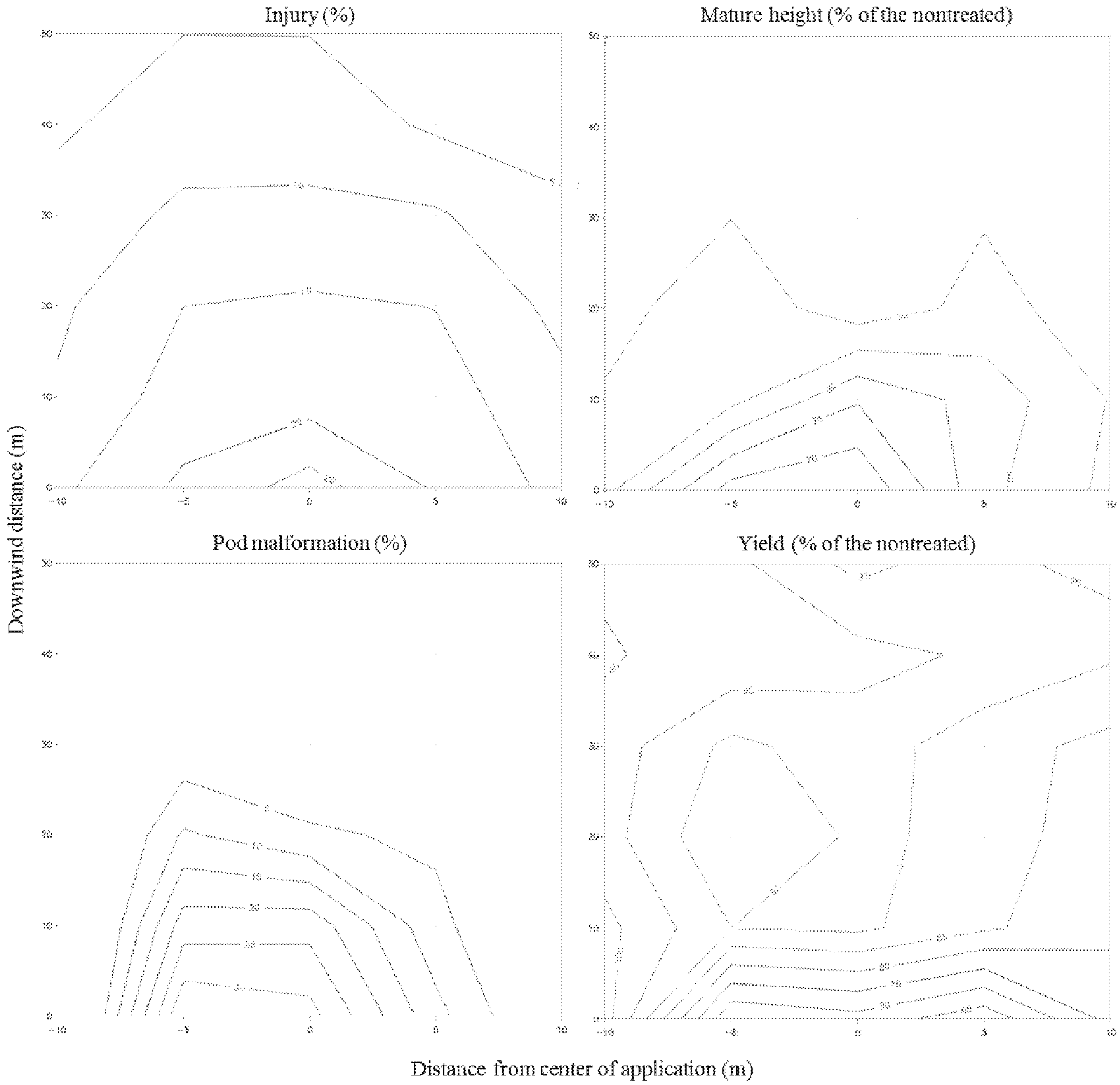
Appendix figure 38. Contour maps illustrating soybean injury, mature height, pod malformation, and yield for trial 13. Soybean injury was rated on a scale from 0 to 100% with 0% being no injury and 100% being plant death. Pod malformation is presented as a percent of total pods malformed. The untreated is the average mature height or yield of 3 random plots within the trial (but outside the drift plume) observed to have no injury at 28 days after application (DAA).



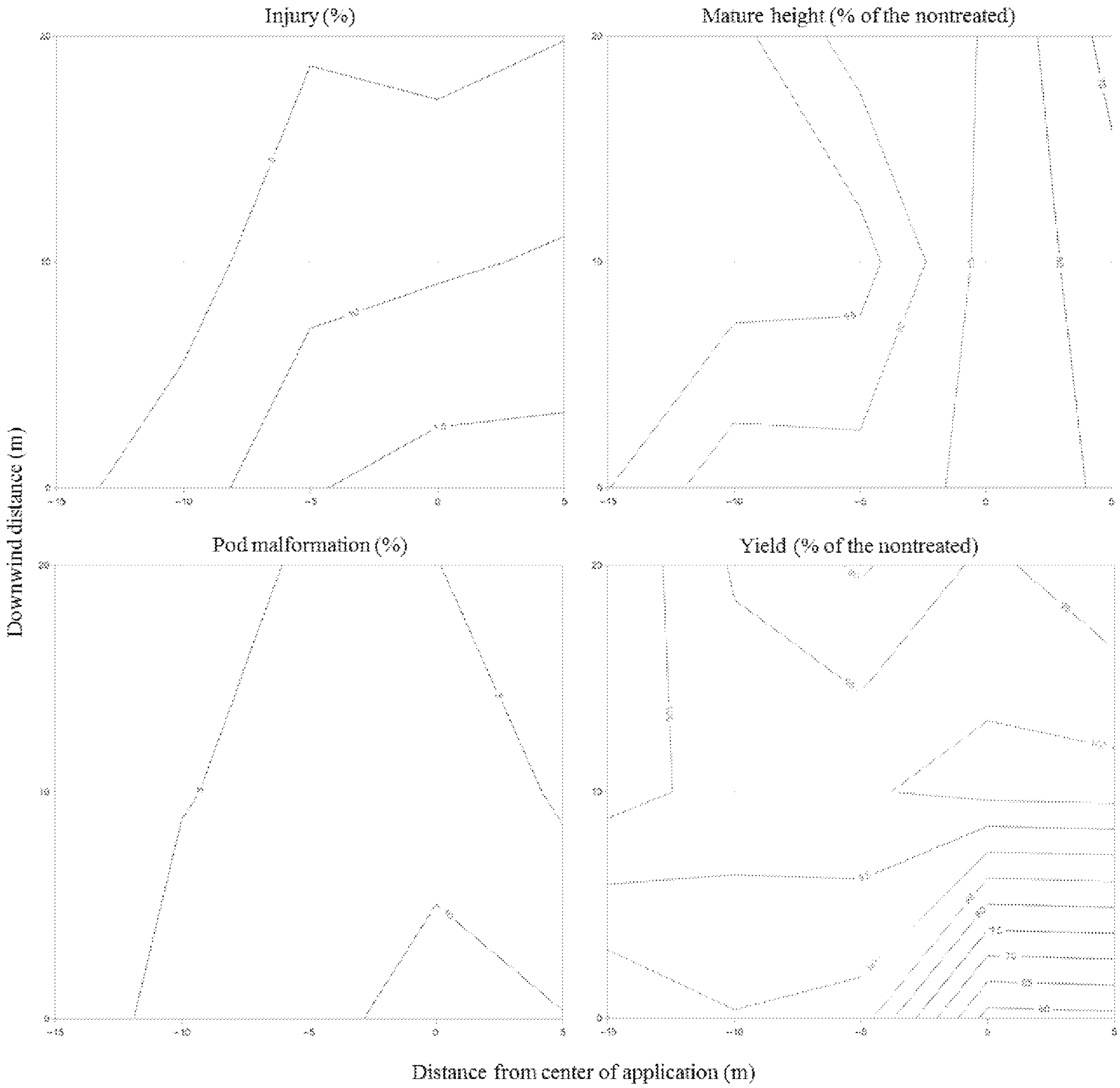
Appendix figure 39. Contour maps illustrating soybean injury, mature height, pod malformation, and yield for trial 14. Soybean injury was rated on a scale from 0 to 100% with 0% being no injury and 100% being plant death. Pod malformation is presented as a percent of total pods malformed. The untreated is the average mature height or yield of 3 random plots within the trial (but outside the drift plume) observed to have no injury at 28 days after application (DAA).



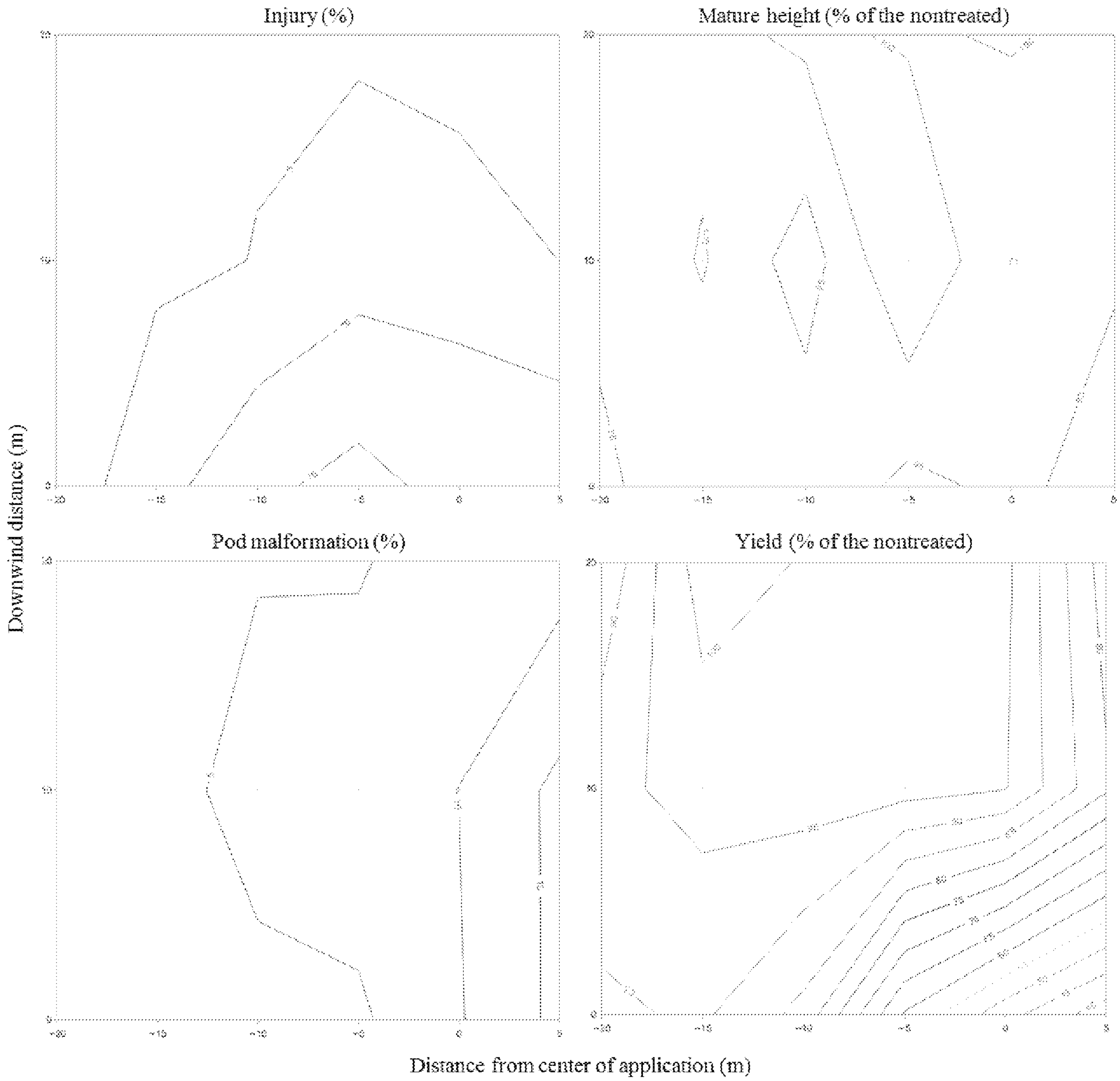
Appendix figure 40. Contour maps illustrating soybean injury, mature height, pod malformation, and yield for trial 15. Soybean injury was rated on a scale from 0 to 100% with 0% being no injury and 100% being plant death. Pod malformation is presented as a percent of total pods malformed. The untreated is the average mature height or yield of 3 random plots within the trial (but outside the drift plume) observed to have no injury at 28 days after application (DAA).



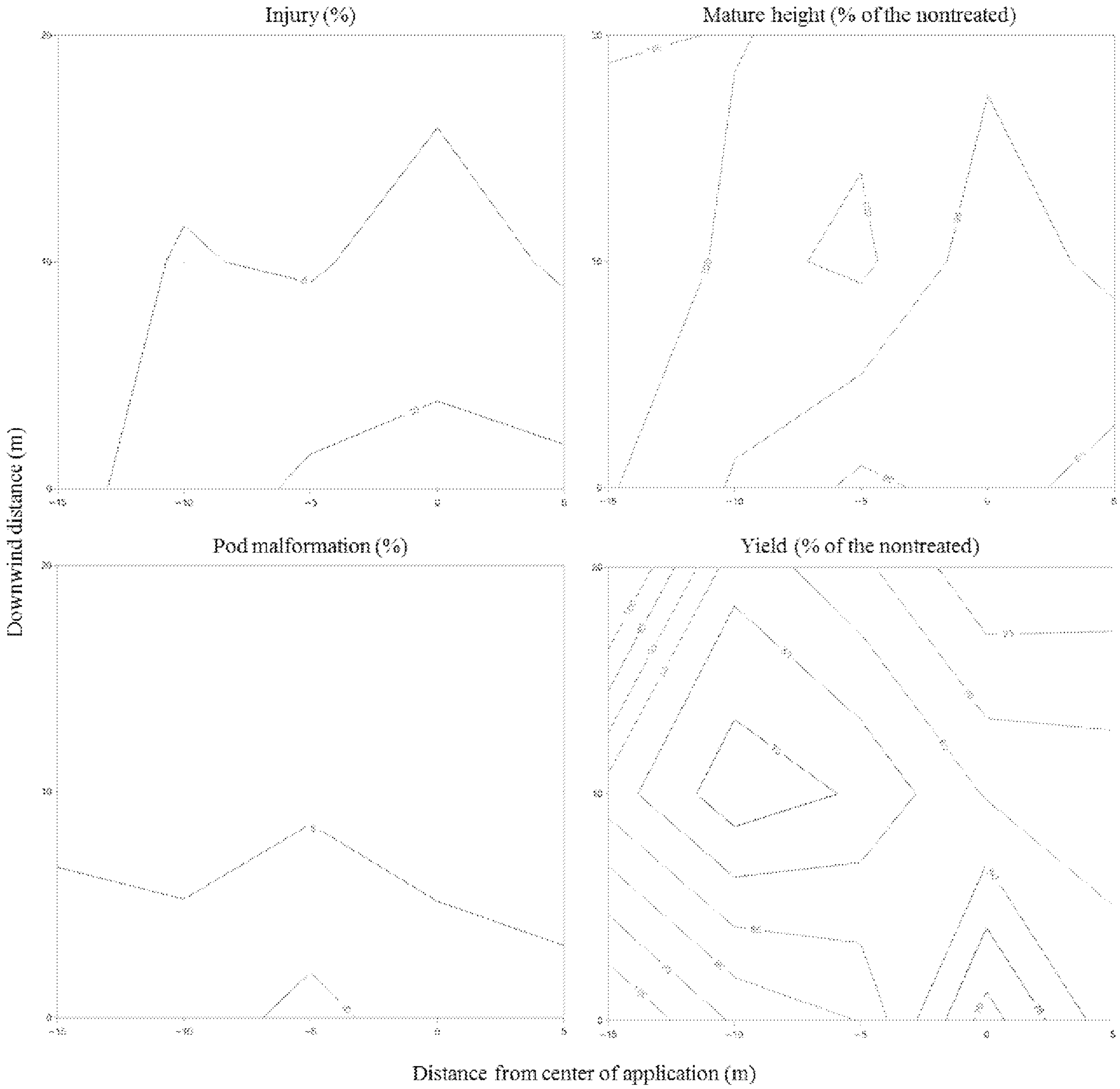
Appendix figure 41. Contour maps illustrating soybean injury, mature height, pod malformation, and yield for trial 16. Soybean injury was rated on a scale from 0 to 100% with 0% being no injury and 100% being plant death. Pod malformation is presented as a percent of total pods malformed. The untreated is the average mature height or yield of 3 random plots within the trial (but outside the drift plume) observed to have no injury at 28 days after application (DAA).



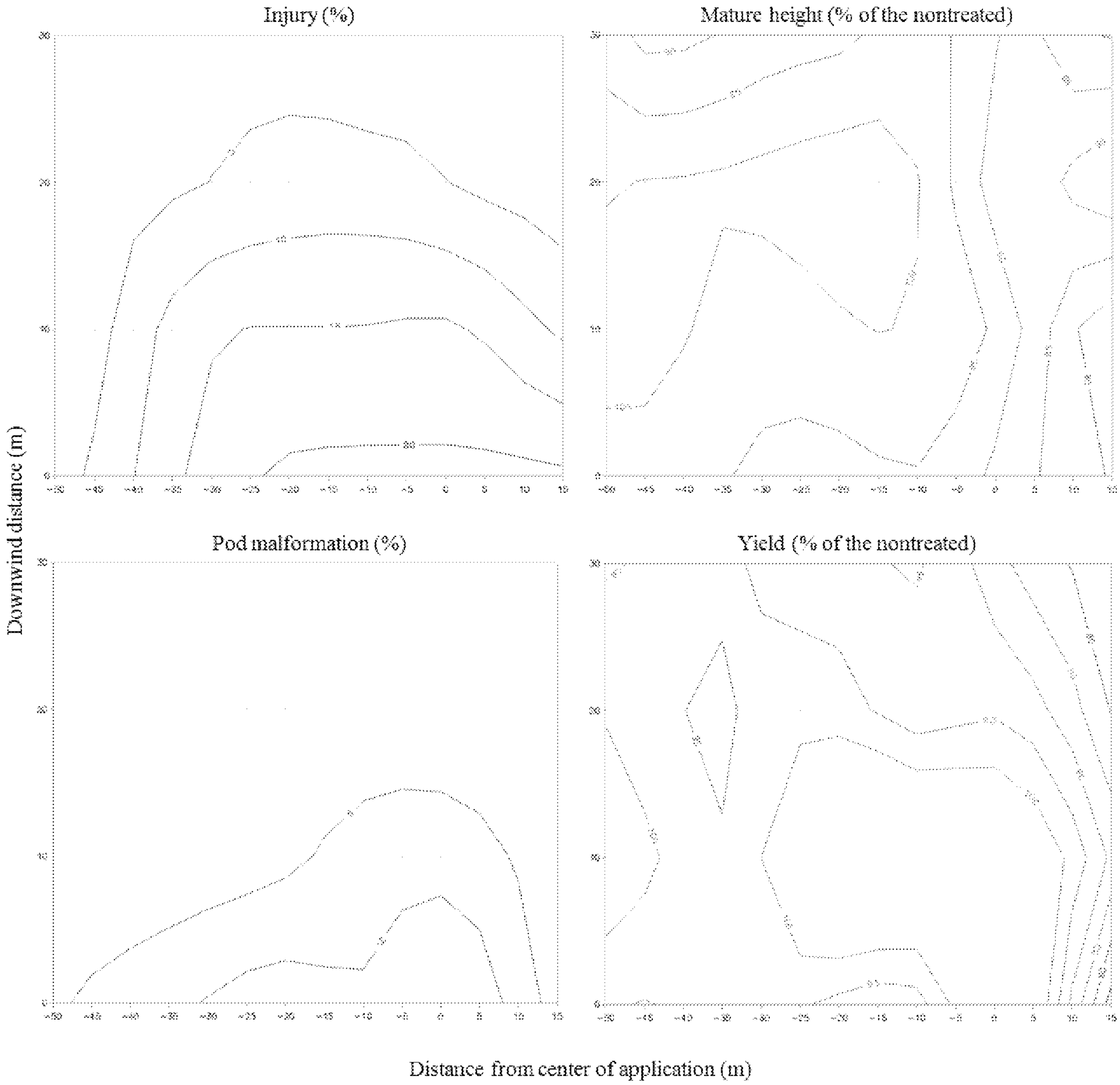
Appendix figure 42. Contour maps illustrating soybean injury, mature height, pod malformation, and yield for trial 17. Soybean injury was rated on a scale from 0 to 100% with 0% being no injury and 100% being plant death. Pod malformation is presented as a percent of total pods malformed. The untreated is the average mature height or yield of 3 random plots within the trial (but outside the drift plume) observed to have no injury at 28 days after application (DAA).



Appendix figure 43. Contour maps illustrating soybean injury, mature height, pod malformation, and yield for trial 18. Soybean injury was rated on a scale from 0 to 100% with 0% being no injury and 100% being plant death. Pod malformation is presented as a percent of total pods malformed. The untreated is the average mature height or yield of 3 random plots within the trial (but outside the drift plume) observed to have no injury at 28 days after application (DAA).



Appendix figure 44. Contour maps illustrating soybean injury, mature height, pod malformation, and yield for trial 19. Soybean injury was rated on a scale from 0 to 100% with 0% being no injury and 100% being plant death. Pod malformation is presented as a percent of total pods malformed. The untreated is the average mature height or yield of 3 random plots within the trial (but outside the drift plume) observed to have no injury at 28 days after application (DAA).



Appendix figure 45. Contour maps illustrating soybean injury, mature height, pod malformation, and yield for trial 20. Soybean injury was rated on a scale from 0 to 100% with 0% being no injury and 100% being plant death. Pod malformation is presented as a percent of total pods malformed. The untreated is the average mature height or yield of 3 random plots within the trial (but outside the drift plume) observed to have no injury at 28 days after application (DAA).

Chapter 2

Response of Soybean Offspring to a Dicamba Drift Event the Previous Year

Abstract

With the advent of dicamba-resistant crops and use of dicamba postemergence to dicamba-resistant soybean and cotton, there will be increased use and thus risk for off-target movement of the herbicide. In the occurrence of dicamba drift, it is not well understood what measurements from soybean plants would correlate with damage to soybean offspring; therefore, possible relationships are of great interest. Sixteen drift trials were established over two years at the Northeast Research and Extension Center in Keiser, AR. A single 8-m-wide by 30- or 60-m-long pass with a high-clearance sprayer was made in each soybean field, resulting in a dicamba drift event. Seeds were collected from plants in each drift trial and planted in a greenhouse in 2015 and 2016. Data were subjected to correlation analysis to determine pairwise associations among parent and offspring observations. Auxin-like symptomology in offspring consistent with dicamba, primarily as leaf cupping, appeared in plots at the unifoliate and first trifoliate stages. Auxin-like symptoms were more prevalent in offspring collected from plants from later reproductive stages as opposed to early reproductive. The highest correlation coefficients occurred when parent plants were treated at R5 growth stage. Parent mature pod malformation was correlated with offspring emergence ($r = -0.37$, $p = 0.0082$), vigor ($r = -0.57$, $p = < 0.0001$), injury ($r = 0.93$, $p = < 0.0001$), and percent of plants malformed ($r = 0.92$, $p = < 0.0001$). This research documents that soybean damaged from dicamba drift during stages of reproduction can negatively affect offspring and that parent pod malformation may be indicative of injury to the offspring. The greatest concern for soybean offspring would be in the occurrence of dicamba drift on seed production fields, causing seed quality to suffer or growers to be alarmed by the

occurrence of auxin-like symptoms on plants soon after emergence. Furthermore, dicamba symptomology occurring in newly emerged soybean could be mistaken as recent drift exposure that may result in dicamba misuse complaints being filed where they are not warranted.

Nomenclature: dicamba; soybean, *Glycine max* (L.) Merr.; cotton, *Gossypium hirsutum* (L.)

Key words: Off-target movement, dicamba-like symptomology, leaf malformation, pod malformation, soybean offspring, soybean growth stages

Introduction

With commercialization of dicamba-resistant (DR) cotton and soybean and labeling of dicamba-containing herbicides for over-the-top use (Anonymous 2016a; Anonymous 2016b), the amount of dicamba applied to U.S. row crops will undoubtedly increase. Approximately 50% of row-crop hectares in Arkansas were planted to soybean in 2015 (United States Department of Agriculture 2016). Therefore, the likelihood of DR cultivars being planted near non-DR soybean is high.

Even with new, lower volatility formulations of dicamba available, primary (physical) drift should still be a concern of growers (Norsworthy et al. 2015). When DR soybean and cotton are planted adjacent to non-DR soybean, applicators must be aware of factors that could contribute to off-target movement since non-DR soybean is highly sensitive to dicamba, and rates as low as 0.08 g ae ha^{-1} (1/7000 X of the 560 g ha^{-1} rate) may cause visible injury symptoms such as leaf crinkling or cupping (Weidenhamer et al. 1989). Correct nozzles, proper boom height, proper spray pressure, and approved mixtures will aid in keeping dicamba from moving off-target via physical drift to susceptible soybean (Anonymous 2017a; Anonymous 2017b; Maybank et al. 1978; Wolf et al. 1992).

The incorporation of DR cultivars into soybean production will increase risk for growers planting non-DR soybean fields. In Arkansas, in-crop labeling of dicamba for DR cultivars will expand current dicamba use for preplant or POST corn (*Zea mays* L.) applications in late February through April and for POST applications on DR soybean and cotton, which likely range from May through August (United States Department of Agriculture 2010). Off-target movement to soybean is less likely to occur from preplant or POST corn applications because fewer soybean hectares have emerged, as soybean planting does not typically begin until late

April in most of Arkansas (United States Department of Agriculture 2016). Likewise, the use rate of dicamba in corn is typically less than that labeled for use in DR cotton and soybean. In addition, March and April temperatures are usually mild, and precipitation is common. Conversely, average temperatures increase in all areas of the US by summer, and precipitation has a tendency to become less frequent. High temperatures have been recognized to increase volatility, and rainfall has been documented to virtually eliminate volatility (Behrens and Lueschen 1979).

As dicamba applications extend into mid-summer, so too does concern for off-target movement to reproductive non-DR soybean. Sensitivity to dicamba differs among soybean growth stages, and yield reduction is highest at early flowering growth stages (Auch and Arnold 1978; Griffin et al. 2013; Solomon and Bradley 2014; Wax et al. 1969). In addition, dicamba exposure to soybean at reproductive stages causes dicamba-like symptomology in its offspring (Thompson and Egli 1973; Wax et al. 1969).

Dicamba is a phloem mobile herbicide (Senseman 2007), meaning that when applied it will inherently move to areas of new growth. Vegetative soybean exposure to dicamba has resulted in greater leaf injury than applications made in later reproductive stages when vegetative growth slows (Kelley et al. 2005; Solomon and Bradley 2014; Weidenhamer et al. 1989). Kelley et al. (2005) reported soybean injury increased from 25 to 37% when dicamba at 0.56 g ha^{-1} was applied at vegetative as opposed to reproductive stages. Solomon and Bradley (2014) documented an 11% decrease in soybean injury when application of dicamba at 0.28 g ha^{-1} was delayed from vegetative stage to R2 growth stage. This is likely due to the increased speed and overall amount of vegetative growth that is occurring at pre-bloom stages. Once reproductive growth begins, vegetative growth in the form of new branches and trifoliate leaves declines as reproductive structures such as flowers and pods begin to form. The amount of dicamba moving to leaves in pre-bloom stages is also likely greater than that of reproductive stages and therefore leads to a greater amount of leaf malformation.

Once in reproductive stages, soybean exposure to dicamba may still result in extensive crop injury, albeit less in the form of leaf malformation and more in reproductive functions. Previous studies have documented as much as 17 and 25% soybean injury from dicamba at 0.28 and 0.56 g ha^{-1}, respectively, applied at the R2 growth stage (Kelley et al. 2005; Solomon and Bradley 2014). The reduction in leaf injury from reproductive exposure compared to vegetative exposure is conveyed in other meristematic regions, such as pods, once reproductive growth begins. Pod malformation can be a result of exposure to dicamba during flowering, with the later developing pods being a possible metabolic sink for dicamba. Pod malformation has been documented as an outcome of exposure to dicamba during flowering (R1 and R2) and early pod forming stages (R3) (Auch and Arnold 1978; Weidenhamer et al. 1989). Percentage of pod injury or percentage of pods showing malformed growth was not previously documented in these studies, only the presence or absence of pod malformation.

The effects of dicamba on soybean have also been documented to extend to the offspring in the form of germination reductions (Auch and Arnold 1979; Thompson and Egli 1973; Wax et al. 1969). Vegetative applications of dicamba at rates ranging from 1 to 56 g ha^{-1} did not result in germination reductions (Auch and Arnold 1979). Germination was relatively unaffected (97%) by dicamba at 8.75 g ha^{-1} when applied to soybean in bloom (Wax et al. 1969). However, application of dicamba at 30 g ha^{-1} during flowering or podfill stages allowed for only 50% germination (Thompson and Egli 1973). Furthermore, germination was reduced by 13 to 46%

from early and late pod formation applications of dicamba at 11 to 56 g ha^{-1} (Auch and Arnold 1979).

In addition to germination reductions, offspring malformation occurs following soybean exposure to dicamba. After application of dicamba at 8.75 to 35 g ha^{-1} to parent plants, offspring developed leaf malformation like that seen after dicamba exposure (Wax et al. 1969). In subsequent research, higher rates of dicamba were used (30 to 560 g ha^{-1}) and the effects were more widespread (Thompson and Egli 1973). Seedlings with dicamba injury were present in all treatments, and severe trifoliate injury appeared in 33 to 100% of offspring.

Soybean exposure to dicamba and subsequent evaluations of offspring have typically been studied after direct applications of low dosages of dicamba to plots rather than using seed from an actual drift event. In addition, past research did not document parameters past the V3 stage of soybean offspring. Therefore, the objective of our research was to examine the season-long effects of an actual dicamba drift event on soybean offspring planted in the field the subsequent season.

Materials and Methods

Field drift experiments were conducted in 2014 and 2015 at the University of Arkansas Northeast Research and Extension Center (NEREC) in Keiser, AR, and offspring experiments were completed at the Arkansas Agriculture Research and Extension Center (AAREC) in Fayetteville, AR, in 2015 and 2016. In 2014, eight dicamba drift experiments were established in commercial production fields at the NEREC with two being treated with dicamba at the R3 growth stage and the remaining six treated at the R1 growth stage of soybean (Table 1). Eight additional dicamba drift experiments were established at the same location in 2015 to obtain data from dicamba application at growth stages R2, R3, R5, and R6. All trials were planted at 31 seed

m^{-1} of row on 97-cm centers. Varieties used are listed in Table 1. A single 8-m-wide by 30- or 60-m- long pass was made with a Bowman Mudmaster (Bowman Manufacturing, Newport, AR) high-clearance sprayer during conditions conducive for a drift event (Figure 1). In the treated area, the diglycolamine (DGA) form of dicamba was applied at 560 g ha^{-1} (Clarity, BASF, Research Triangle Park, NC). A non-ionic surfactant was also included in the spray solution at 0.25% v/v (Induce, Helena Chemical Co, Collierville, TN). The spray boom was equipped with AIXR 11003 nozzles (TeeJet Technologies, Springfield, IL) and calibrated to deliver 94 L ha^{-1} at 275 kPa per the anticipated guidelines for the use of dicamba in DR crops (Anonymous 2013). Each application was made with a 60-cm boom height above the soybean canopy while traveling at 15 km h^{-1}. The treated area was 30 m in length for applications when wind directions were less than 45 degrees from the sprayer traveling direction. The field was grid sampled into four rows (spaced 97 cm apart) by 6-m-long plots extending from the application area until no injury was observed at 14 and 28 days after application (DAA). Applications occurring when the wind direction was greater than 45 degrees from the application direction were 60 m in length. Transects were established at 15, 30, and 45 m along the application area that extended perpendicular to the rows. Four-row by 10-m plots were established along each transect until no injury was observed at 14 and 28 DAA. Regardless of wind direction, only the center two rows of each plot within each transect were used for data collection.

Measurements on the parent plants included visual estimates of leaf malformation on a 0 to 100% scale, with 100% being plant death, at 14 and 28 DAA, soybean height at 28 DAA and maturity, percentage of malformed pods at maturity, and grain yield adjusted to 13% moisture. Height and yield measurements were later converted to percentages of the nontreated check plots. Five plots from each trial that were documented to have no leaf malformation at 28 DAA were used to calculate the nontreated check averages for height and yield. A sample (approximately 1 kg) of seed was taken from each plot after harvest and placed in a freezer maintained at -10 C until the following spring when planting occurred.

Seed collected from the 2014 and 2015 drift trials were planted at AAREC in 2015 and 2016, respectively, at 25 seed m^{-1} row in 6-m-long plots on a 91-cm spacing. The site consisted of a Captina silt loam (Fine-silty, siliceous, active, mesic Typic Fragiudults) with a pH of 6.1 and 1.18% organic matter. The field was furrow irrigated weekly if at least a 2.5-cm rainfall did not occur. Initial planting in 2015 was April 26; however, injury in the form of stand loss was caused by preemergence (PRE)-applied flumioxazin (Valor SX, Valent Corporation, Walnut Creek, CA), after which the test was replanted in a different field on June 25. No PRE herbicides were used thereafter to avoid herbicide injury. In 2016, initial planting occurred on May 19. Stand loss occurred due to soil crusting and pigeon (*Columba livia*) feeding in isolated areas of the field to the extent that the experiment was replanted June 9. All varieties were glufosinate-resistant for ease of weed control (Table 1). Multiple varieties were used but all were indeterminate growth habit to reduce variability in response. Currently there is no available research documenting differences in dicamba sensitivity of soybean within growth habit. Experiments were kept weed-free with a POST application of glufosinate (Bayer CropScience, Research Triangle Park, NC) at 595 g ai ha^{-1} and *S*-metolachlor (Syngenta Corporation, Greensboro, NC) at 1,390 g ai ha^{-1} at 21 days after planting (DAP) followed by a second application of glufosinate two weeks later.

Measurements from the offspring included emergence (% of planted seed emerged), vigor (1 to 5), injury at 21 DAP (% visible injury on a 0 to 100% scale with 100% being plant death), number of plants malformed per plot (converted to % of plants showing malformation), and grain yield adjusted to 13% moisture (kg ha^{-1}). Soybean vigor was rated on a scale of 1 to 5 for each plot using the following criteria: 1 = extremely low vigor (slow initial growth with delayed emergence or reduced emergence of >60% under field conditions), 2 = poor vigor (slow initial growth and 30 to 60% reduction in emergence in the field), 3 = moderately low vigor (average initial growth with slight reduction in emergence likely under good field conditions), 4 = moderately high vigor (average initial growth with slight reduction in emergence likely in fields having suboptimal conditions), 5 = extremely high vigor (seedlings quickly emerge; exhibit rapid growth; likely to emergence under a wide array of field conditions). Although a standardized definition of vigor satisfactory to most investigators has yet to be realized, the concept of vigor and its importance in crop development are well accepted (Pollock and Roos 1972). Yield was later converted to percentages relative to the nontreated plots. Five plots from each trial that were documented to have no parent leaf malformation at 28 DAA the previous year were used to calculate the nontreated treatment averages for offspring yield. Data were subjected to correlation analysis using JMP 12 PRO (SAS Institute, Cary, NC) to determine Pearson pairwise correlations among parent and offspring observations.

Results and Discussion

R1 Drift Events. Previous research found soybean exposure to dicamba in early reproductive stages to be detrimental to grain yield (Auch and Arnold 1978; Wax et al. 1969). However, drift events occurring at R1 growth stage resulted in only one significant correlation between parent and offspring variables. Relative mature height of the parent was significantly correlated with offspring injury ($r = -0.13$) (Table 2; Figure 2). Terminal node inhibition can occur to soybean exposed to dicamba drift or tank contamination. Events that lead to terminal node inhibition will likely result in height reduction at maturity. Solomon and Bradley (2014) documented yield loss to coincide with height reduction caused by dicamba concentrations as low at 2.8 g ha^{-1} (1/400th

of the labeled use rate in soybean) applied at early reproductive soybean stages. Height reduction may be the greatest predictor of yield of soybean directly exposed to dicamba, likely because plants experiencing terminal inhibition received the greatest concentration of dicamba. This may be of significance for soybean offspring. Soybean plants exposed to a drift event may have ample time to detoxify lower concentrations of dicamba; however, higher concentrations may remain active in the plant through seed fill and therefore transported to the seed.

R2 Drift Events. A delay in drift events until R2 provided nine significant linear correlations between parent and offspring variables (Table 2). Soybean parent leaf malformation at 28 DAA was significantly correlated with offspring injury ($r = 0.46$; $p = < 0.0001$) and percent of offspring plants malformed ($r = 0.47$, $p = < 0.0001$). Scatterplots visually document that increased parent leaf malformation leads to an increased risk for offspring injury and percent of plants malformed (Figure 3). Although previous research has documented that visible estimates of injury from dicamba may be a poor indicator and overestimate yield loss (Egan et al. 2014), these data reveal that increased leaf malformation to parent plants after exposure at R2 is a somewhat reliable indicator in the likelihood of dicamba-like symptomology rematerializing in the subsequent offspring.

Parent height at 28 DAA and at maturity following an R2 dicamba drift event was correlated negatively with offspring injury (Table 2). Percent of offspring plants malformed increased with a decrease in parent height at 28 DAA ($r = -0.18$, $p = 0.0011$) and maturity ($r = -0.39$, $p = < 0.0001$). As with R1 applications, it appears that parent height at maturity is a better indicator of possible effects on soybean offspring than height at 28 DAA. Soybean plants experience a decreased rate of vegetative growth as flowers begin to become an energy sink, and therefore, the effect on height reduction may not be realized until plants achieve maximum height.

Perhaps the most intriguing and strongest correlation at this R2 growth stage existed between percentage of parent pods malformed and the offspring variables injury ($r = 0.59$, $p = < 0.0001$) and percentage of plants injured ($r = 0.58$, $p = < 0.0001$) (Table 3). These findings document that prior to pod forming stages, a dicamba drift event may still result in an excessive number of pod malformation on offspring. Dicamba drift onto R2 soybean resulted in up to 75% of pods being malformed nearest the source of the drift (data not shown). As a soybean plant is exposed to increasing amounts of dicamba, pod malformation may increase at this stage because more dicamba will remain active in the plant through pod forming stages. It is thought that non-metabolized dicamba present in the plant after pod formation will likely be transported to the seed during seed filling stages (Thompson and Egli 1973). Thus, high numbers of malformed pods resulting from an R2 drift event can result in injury to offspring.

R3 Drift Events. Thompson and Egli (1973) documented offspring trifoliate injury to increase two-fold when low doses of dicamba were applied to parent plants during pod forming stages compared to flowering. With an actual dicamba drift event, maximum percentage of offspring injured increased from 11% after R1 events to 50% from R3 drift events (data not shown). Therefore, with delayed drift exposure, soybean has less time to metabolize dicamba prior to it being moved to the sink once seed fill begins. Exposure of soybean to radiolabeled dicamba at different reproductive growth stages and assessing the metabolites is one way to test this hypothesis.

Percentage of malformed parent pods displayed the highest correlation coefficients for offspring vigor, injury, and percentage of plants injured (Table 2; Figure 4). As with R2 drift events, parent plants exposed to R3 drift events displayed extensive pod malformation, which ranged from 0 to 70% depending on distance from the drift event (data not shown). The vast range of pod malformation aided in picking up correlations among offspring variables when even slight changes in injury and vigor were noticed. Based on these data, the amount of pod malformation seen after an R3 drift event could be used to assess the likelihood of soybean offspring having reduced vigor and dicamba-like symptoms.

R5 Drift Events. Drift events at R5 resulted in a significant correlation between parent pod malformation and offspring emergence ($r = -0.37$, $p = 0.0082$), which was the only occurrence of a relationship with offspring emergence in these experiments (Table 2; Figure 5). It may be that the presence of dicamba at the beginning of seed formation allowed for more dicamba to be moved to the seed, resulting in a concentration high enough to reduce emergence. In other research, soybean exposure to a sub-lethal dose of dicamba at the R5 growth stage was shown to reduce germination of the offspring (Barber et al. 2015).

Percentage pod malformation of parent plants was involved with more and higher correlations than any other parent variable. However, percentage of parent pods malformed ranged from only 0 to 15%, which likely led to the steeper correlations (data not shown). The decrease in pod malformation from 75 and 70% maximums at R2 and R3 to 15% at R5 (data not shown) can be explained by the focus of plant growth at the time of application. At R2, plants have yet to start pod formation, and R3 marks only the presence of a 0.5-cm pod on the upper four nodes, whereas R5 denotes the completion of pod formation and the beginning of seed growth (although the plant continues to flower and produce pods/seeds near the terminals). Dicamba remaining in the soybean plant after R2 and R3 exposure has the capacity to disrupt pod formation to a much greater extent than exposure at R5, as pod formation has concluded by

R5. However, pod malformation was still seen after R5 exposure due to the indeterminate growth habit of the soybean variety. Malformed pods were seen only in the uppermost nodes that were still showing growth. Furthermore, with the drift event occurring after most pods were formed, dicamba could rapidly move to the seed. Thus, an increase in the number of malformed offspring would be expected. In fact, the maximum amount of plants injured per plot increased from 50% after R3 drift events to 99% after R5 drift events (data not shown). Therefore, after an actual dicamba drift event at R5 growth stage, high numbers of malformed parent pods may indicate the likelihood for more offspring plants to display abnormal growth and a higher percentage of offspring injury as well as a possible decrease in offspring vigor and emergence.

R6 Drift Events. Parent injury and canopy heights 28 DAA could not be recorded after R6 drift events as leaf drop had started to occur approximately 2 weeks after application and plants were mature in most cases at 28 DAA. Lack of growth after initiation of drift events to R6 soybean likely led to the absence of significant correlations with parent pod malformation and mature height. Furthermore, since injury was not obvious, plots only extended 18 to 24 m from the drift event. Parent mature height was reduced by a maximum of only 11% after R6 application, whereas earlier applications reduced mature height by as much as 61% (data not shown). Parent pod malformation was nearly nonexistent and only ranged from 0 to 1% (Figure 6).

Relative yield of offspring was reduced by as much as 42% at R6 and was the only parent variable to be correlated with offspring variables. As the relative yield of parent plants decreased, so did offspring vigor ($r = 0.41$, $p = 0.0028$) (Table 2). Reductions in offspring injury ($r = -0.43$, $p = 0.0016$) and percent of plants injured ($r = -0.49$, $p = 0.0028$) were documented when parent relative yield was increased (Figure 6). Yield reduction may occur for a multitude of reasons, and this research documents that dicamba exposure to soybean at R6 may not be identifiable due to lack of leaf or pod malformation. For these reasons, dicamba exposure to soybean at R6 may be most worrisome to the seed production industry. General germination tests may not identify dicamba exposure because offspring of soybean exposed to drift events at R6 did not have a noticeable reduction in emergence. If dicamba exposure is suspected, soybean offspring may need to be grown to the V2 or V3 stages to examine if leaf malformation will appear.

Practical Implications. It is possible that the replanting of this study later in summer may have resulted in better growing conditions than those early in the spring; therefore, an even greater difference in vigor may result under less than ideal growing conditions following planting. Yield loss is perhaps the most important variable for most growers. The replanting of these trials coincided more with a double-crop planting date, likely resulting in reduced yield from full-season planting dates. Typically, double-crop soybean is planted in narrow rows to maximize yield as reduced vegetative growth will occur when compared to full-season soybean (Harder et al. 2007; Johnson et al. 2002). It is likely that a decrease in row spacing would have increased the capacity to yield by increasing leaf area index and shortening the amount of time until soybean canopy formation (Harder et al. 2007). Further research is needed to examine the relationship between offspring yield after parent exposure to dicamba.

The potential to have dicamba applied near fields of soybean that are already in reproductive stages is high in the midsouthern USA. In Arkansas, soybean has a wide window of planting time that ranges from April through July (NASS 2010). Therefore, early-planted soybean could be in close proximity to late-planted double-crop soybean. Applications of dicamba to DR double-crop soybean would take place at a time when neighboring early-season soybean will be in reproductive stages. It is well known that soybean is highly sensitive to dicamba, and this research documents that effects may be transmitted to offspring from actual drift events at reproductive stages.

One instance of concern is dicamba drift onto seed production fields. Dicamba symptomology was not readily visible when actual drift events occurred at seed filling stages. For example, there was an overall reduction in parent leaf malformation caused by dicamba drift with progression of soybean maturity as seen in Figures 2 to 6. Therefore, exposure to dicamba may not be realized without close inspection of fields during reproductive development. Subsequent germination tests may pick up seed exposed to higher rates as documented in previous research (Auch and Arnold 1978; Thompson and Egli 1973). However, these actual drift events only produced one significant relationship with offspring emergence, which occurred with parent pod malformation at R5 timing. Therefore, it is possible for contaminated seed to germinate normally, yet still display auxin-like symptomology after germination. Thus, seeds that have been unknowingly exposed to a dicamba drift event may be distributed to growers, and after emergence, plants may display dicamba-like symptoms and cause growers to place blame on others.

Although there is a need for DR technology to provide diversity in soybean weed control programs and to manage resistant weeds, the risk for damage to neighboring soybean fields and contamination of seed production fields should be weighed. Previous studies have documented the dangers of dicamba to soybean seed production on a small scale with direct application; however, these experiments document that those effects can also be seen after actual dicamba drift events and extreme caution is needed when applying dicamba in the vicinity of non-DR soybean.

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Table 1. Year, trial, soybean variety, growth stage, and number of observations in parent drift trials at the Northeast Research and Extension Center in Keiser, AR.

Year	Trial	Variety	Growth stage	Observations
2014	14-1	Progeny 4819	R1	88
2014	14-2	Halo 494	R1	84
2014	14-3	Halo 494	R1	76
2014	14-4	Halo 494	R1	104
2014	14-5	HBK 4850	R1	54
2014	14-6	HBK 4850	R1	65
2014	14-7	Progeny 4819	R3	65
2014	14-8	Progeny 4819	R3	57
2015	15-1	Delta Grow 4767	R3	63
2015	15-2	Delta Grow 4767	R3	50
2015	15-3	Credenz 4950	R2	188
2015	15-4	Credenz 4950	R2	132
2015	15-5	Progeny 4814	R5	52
2015	15-6	Credenz 4950	R6	15
2015	15-7	Credenz 4950	R6	15
2015	15-8	Progeny 4814	R6	21

Table 2. Pearson's correlation coefficients between parent and offspring variables at each respective growth stage.[ab]

Parent variables	Growth stage	Offspring variables: Emergence (%)	Vigor	Injury (%)	% of plants injured	Relative yield (%)
Leaf malformation at 28 DAA (%)	R1	-0.04	-0.02	0.06	0.01	0.10
	R2	-0.08	-0.12	0.46*	0.46*	0.12
	R3	-0.02	-0.02	0.45*	0.31*	-0.17
	R5	-0.23	-0.41*	0.74*	0.72*	-0.22
	R6	-	-	-	-	-
Height at 28 DAA[c] (% of check)	R1	0.03	0.09	-0.05	0.00	-0.12
	R2	-0.05	0.02	-0.21*	-0.18*	-0.10
	R3	-0.01	0.00	-0.31*	-0.16	0.07
	R5	-0.27	-0.26	0.39*	0.38*	-0.08
	R6	-	-	-	-	-
Height at maturity (% of check)	R1	-0.01	0.01	-0.13*	-0.02	-0.10
	R2	0.11	0.10	-0.37*	-0.39*	0.00
	R3	0.06	0.00	-0.21*	-0.06	0.19*
	R5	0.11	0.05	-0.09	-0.09	-0.09
	R6	0.18	0.18	-0.23	-0.21	0.31
Pods malformed (% of total)	R1	-0.07	-0.07	0.10	0.01	0.07
	R2	-0.06	-0.09	0.59*	0.58*	-0.02
	R3	-0.15	-0.21*	0.51*	0.41*	-0.04
	R5	-0.37*	-0.57*	0.93*	0.92*	-0.34
	R6	0.18	-0.35	0.33	0.32	0.03

Table 2 continued

Parent variables	Growth stage	Offspring variables				
		Emergence (%)	Vigor	Injury (%)	% of plants injured	Relative yield (%)
Relative yield (%)	R1	-0.02	0.08	-0.09	-0.01	-0.01
	R2	-0.15	-0.12	-0.03	-0.01	0.30*
	R3	0.04	0.11	-0.39*	-0.26*	0.05
	R5	0.01	-0.09	0.13	0.13	0.02
	R6	0.15	0.41*	-0.43*	-0.49*	0.09

[a]*Indicates significance to $\alpha = 0.01$

[b]Sample sizes: R1(471), R2(320), R3(235), R5(52), R6(51)

[c]Days after application

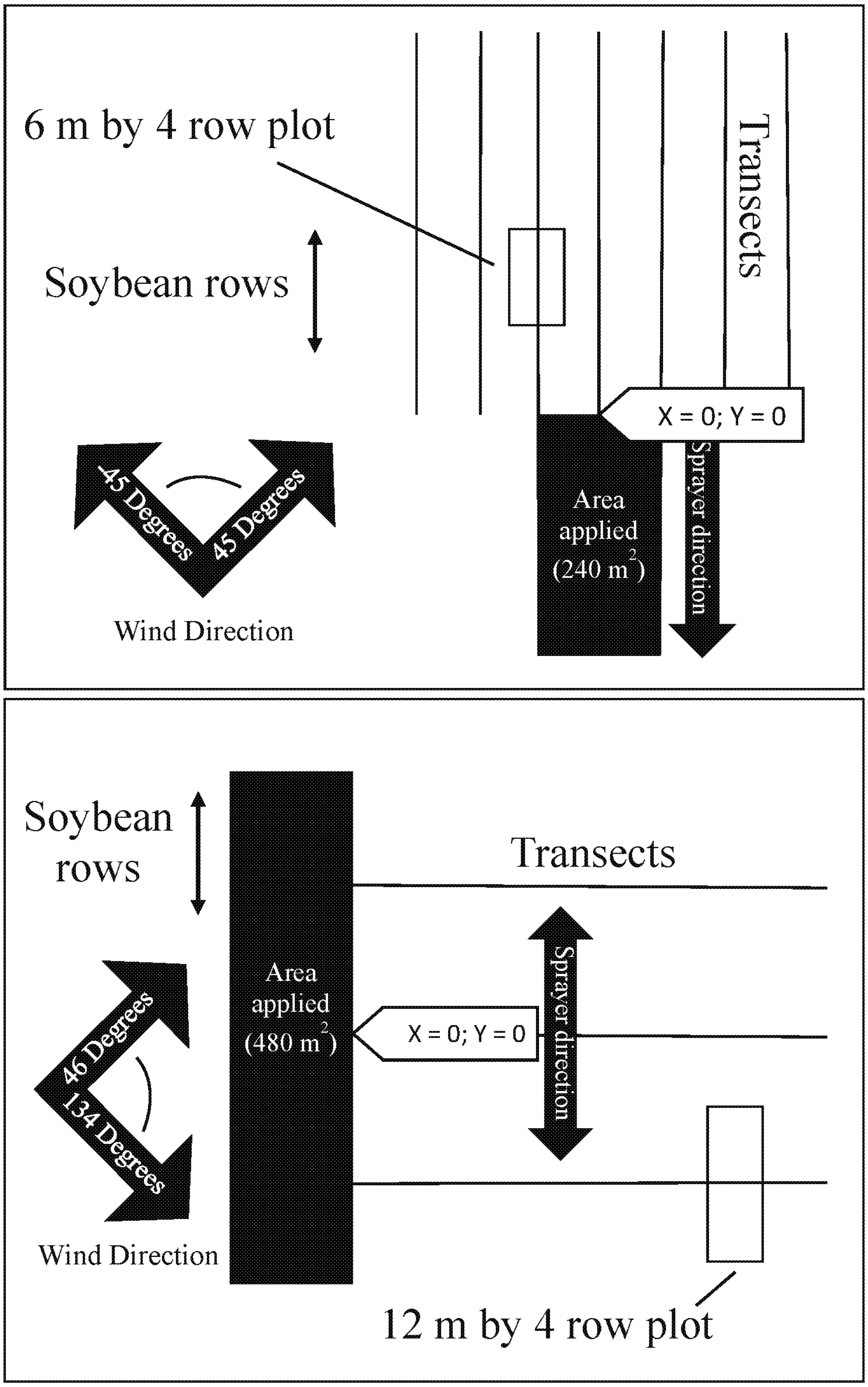

Figure 1. Illustration of drift trial layout for different wind directions.

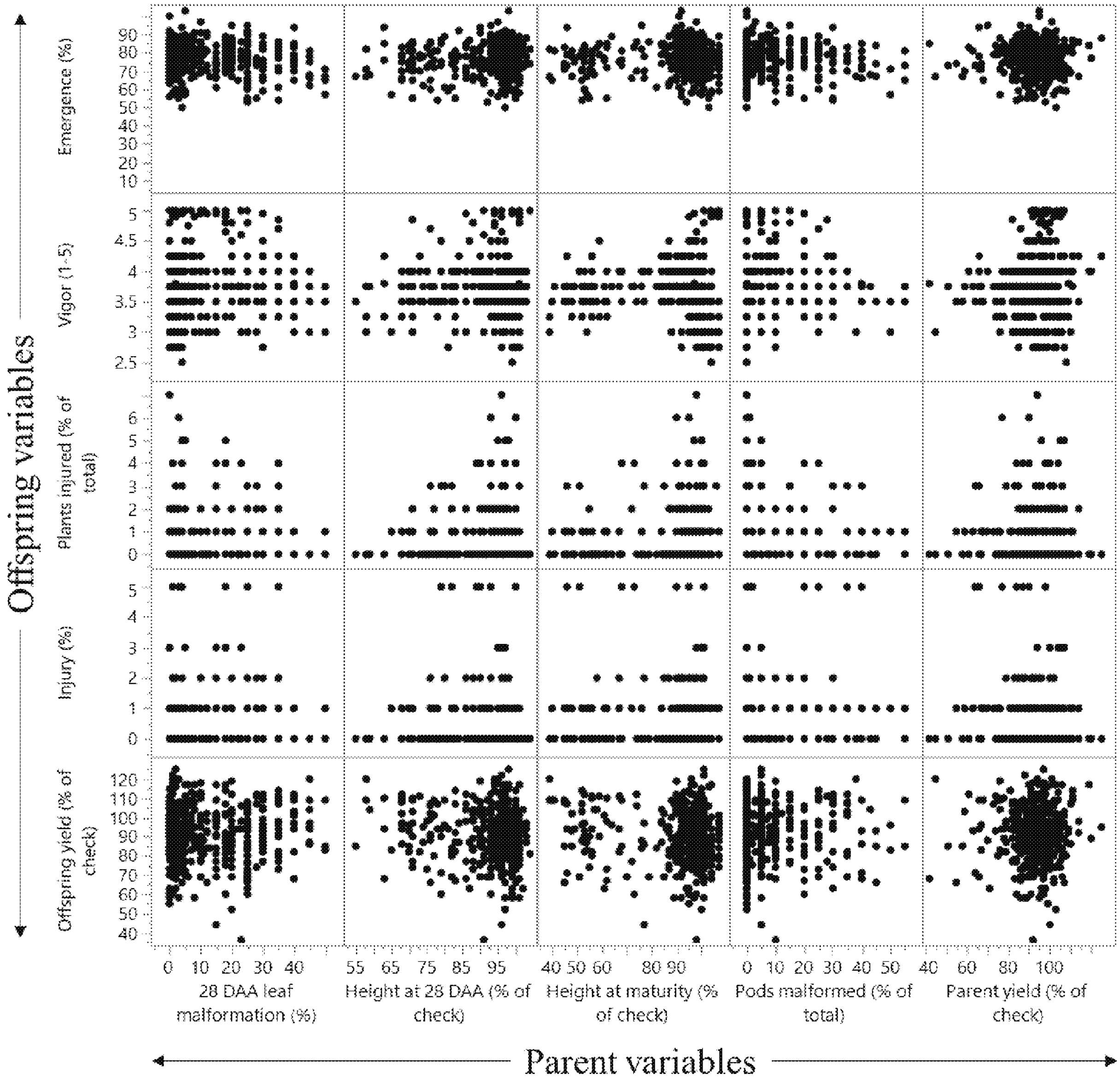

Figure 2. Scatterplot matrix for relationships between parent and offspring variables for R1 drift trials.

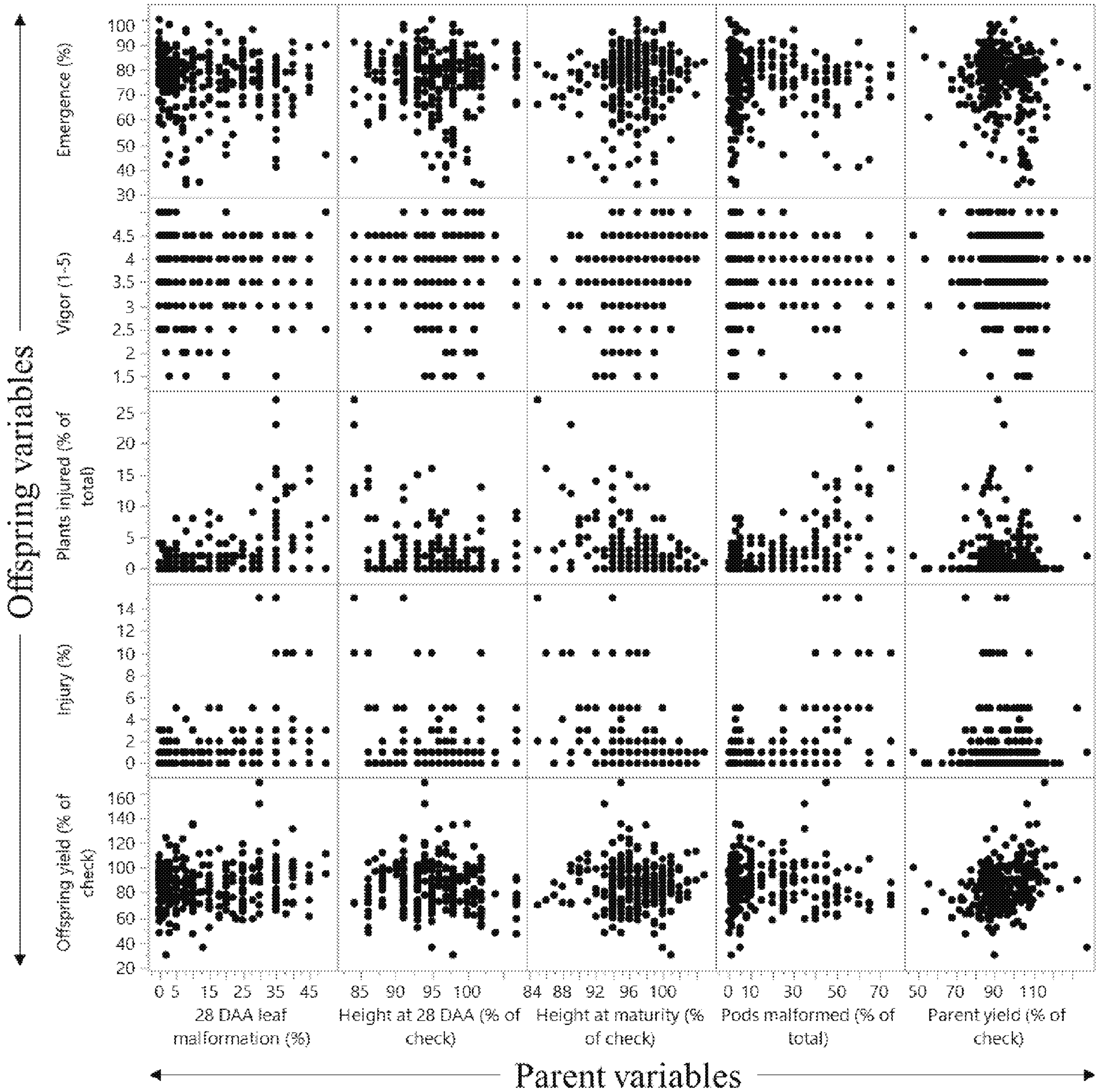

Figure 3. Scatterplot matrix for relationships between parent and offspring variables for R2 drift trials.

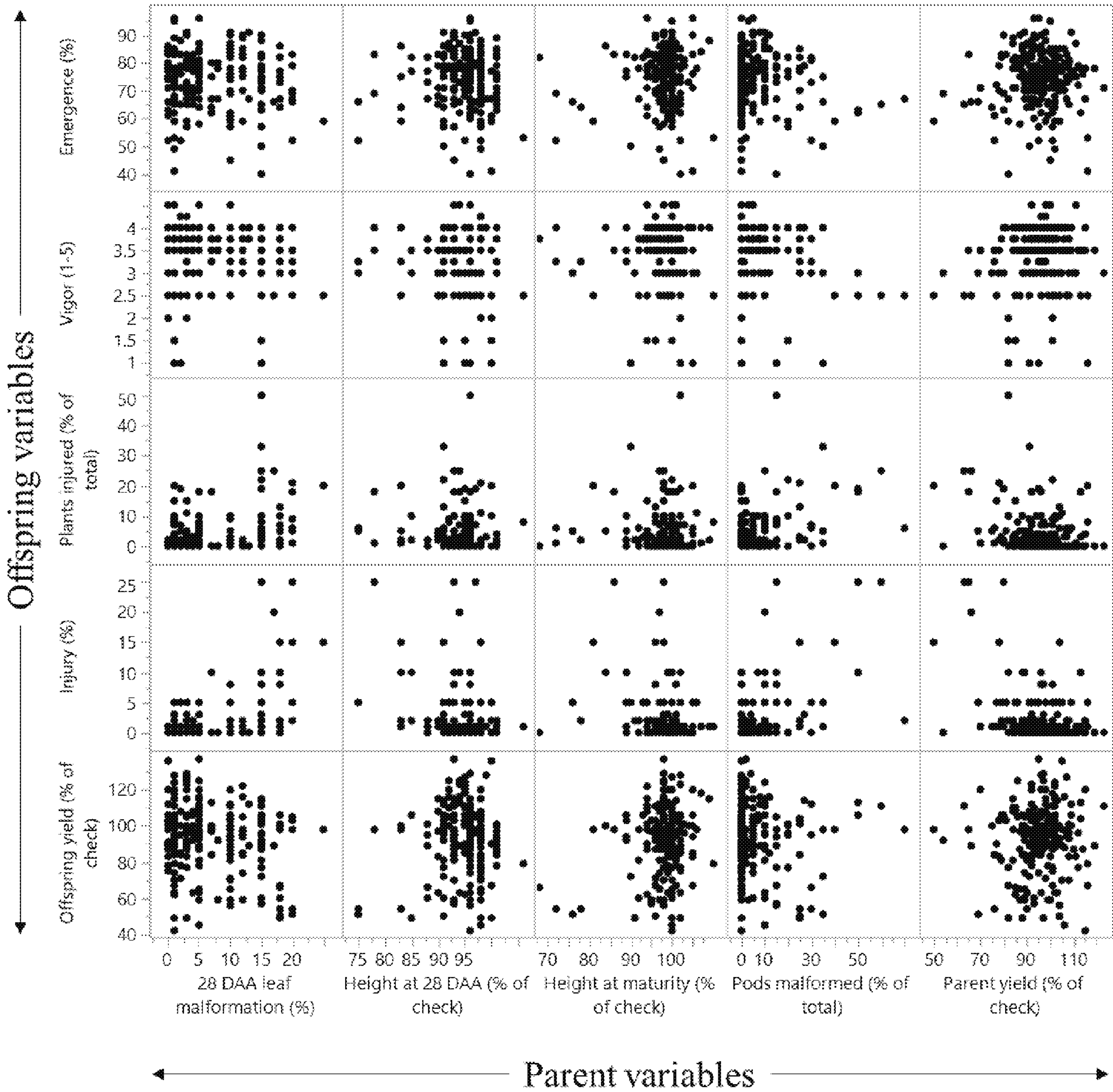

Figure 4. Scatterplot matrix for relationships between parent and offspring variables for R3 drift trials.

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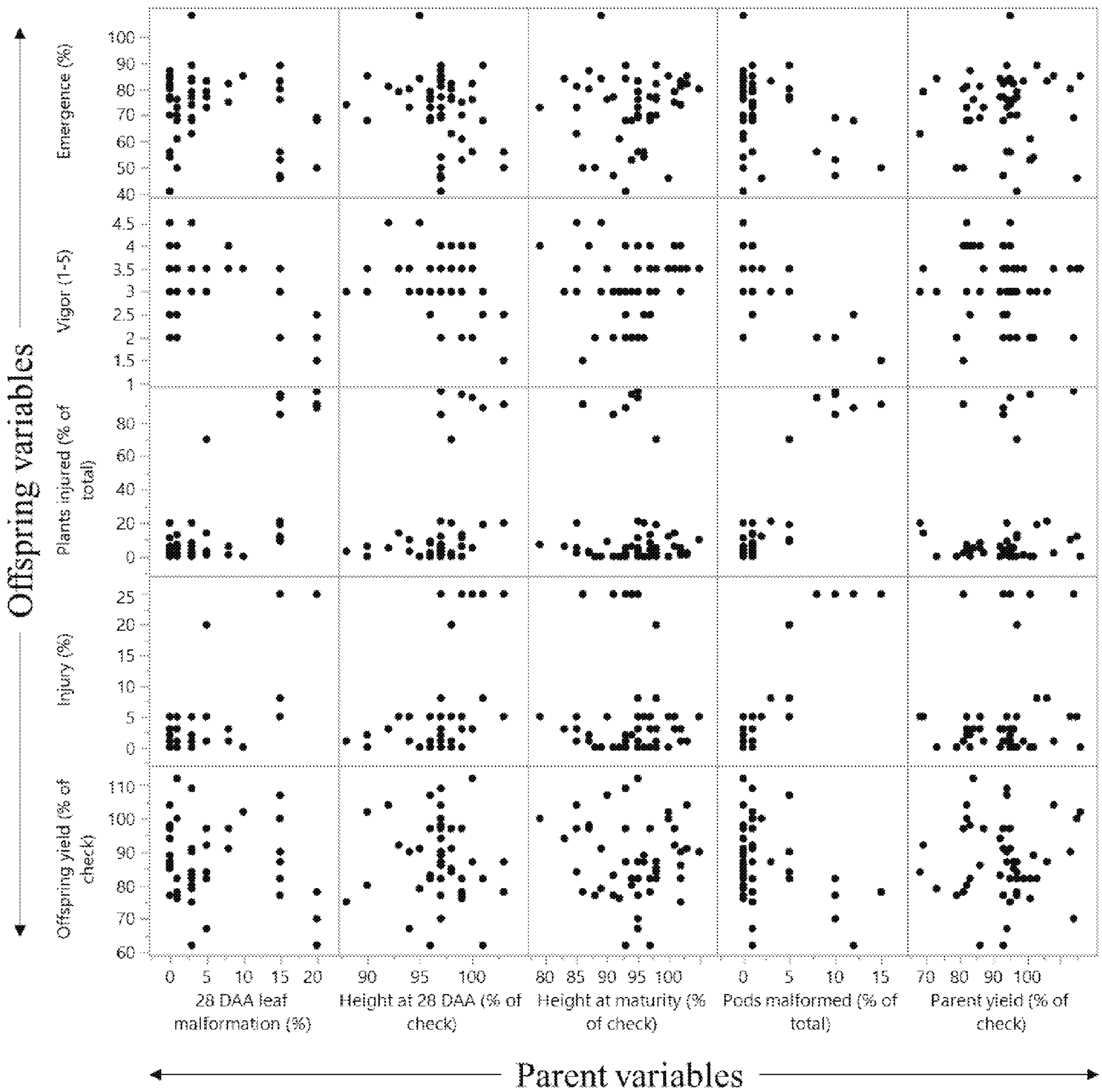

Figure 5. Scatterplot matrix for relationships between parent and offspring variables for R5 drift trials.

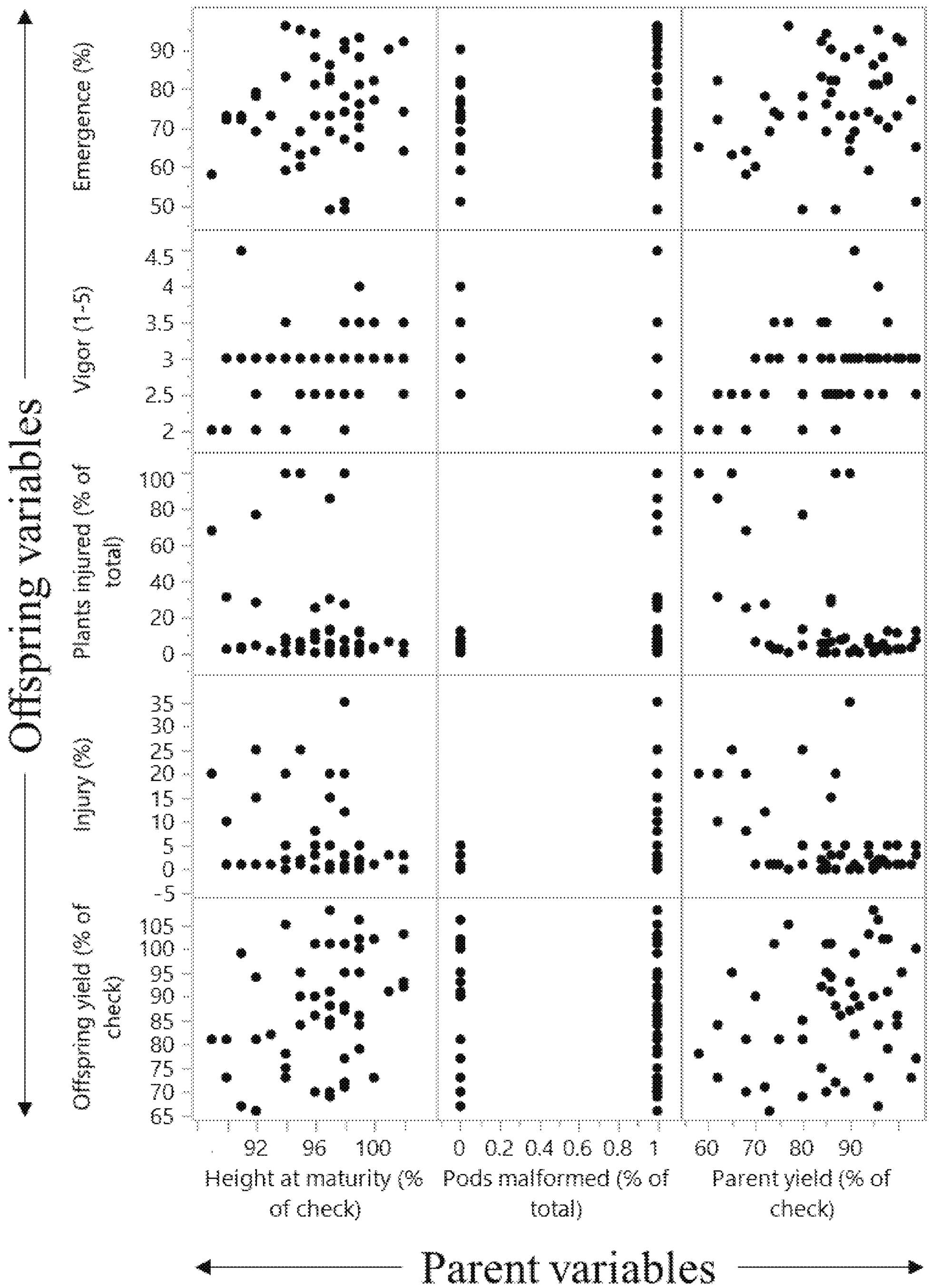

Figure 6. Scatterplot matrix for relationships between parent and offspring variables for R6 drift trials.

Chapter 3

Effect of Low Doses of Dicamba Alone and in Combination with Glyphosate on Parent Soybean and Offspring

Abstract

It is well established that non-dicamba-resistant soybean is highly sensitive to off-target movement of dicamba. However, there is limited knowledge on the effect of low doses of dicamba plus glyphosate mixtures on non-dicamba-resistant soybean – a mixture likely to be used on a vast acreage of dicamba/glyphosate-resistant soybean. Decreased vigor and an expression of dicamba-like symptoms on soybean offspring after exposure to a low dose of dicamba have been established; however, it is unclear if the addition of glyphosate may exaggerate these effects. The objective of this experiment was to examine leaf and pod malformation, along with height and yield effects when dicamba, glyphosate, or a mixture of the two are applied to glufosinate-resistant soybean (non-dicamba-glyphosate-resistant) at sublethal doses. Field applications were made at three growth stages (R1-initial flowering, R3-beginning pod formation, and R5-beginning seed formation) at multiple locations. Two glyphosate rates (1/64 and 1/256 of the labeled rate 870 g ae ha^{-1}) and two dicamba rates (1/64 and 1/256 of the labeled rate 560 g ae ha^{-1}) were used in the study. Adding glyphosate to dicamba increased leaf malformation over dicamba alone when applied at R1. After R3 applications, pod malformation was greater in treatments containing dicamba and glyphosate than dicamba alone. Applications at R5 showed minimal leaf and pod malformation. Seed from field trials were planted in the greenhouse to evaluate the offspring. The number of offspring plants showing dicamba-like symptomology was not increased with the addition of glyphosate to dicamba. Overall, injury to offspring was similar in dicamba alone and dicamba plus glyphosate treatments; however, the number of plants injured increased when parent plants were exposed to sublethal doses of dicamba at R3 and R5 compared to R1 exposure. Vigor was reduced in dicamba-containing treatments, but not glyphosate-alone treatments. Glyphosate addition to dicamba had no effect on vigor of soybean offspring. Although there is increased injury to parent plants when glyphosate is added to dicamba, this research demonstrates that glyphosate does not contribute to the negative effects of dicamba on soybean offspring.

Nomenclature: Dicamba; glyphosate; soybean, *Glycine max* (L.) Merr.

Key words: Off-target movement, dicamba symptomology, leaf malformation, pod malformation, soybean offspring, dicamba-resistant cotton, dicamba-resistant soybean

Introduction

Dicamba-resistant (DR) cotton (*Gossypium hirsutum* L.) and soybean have been deregulated by the Environmental Protection Agency (EPA) and commercially launched in 2015 and 2016, respectively. Registration of dicamba-containing products (Xtendimax with VaporGrip, Monsanto Corporation, St. Louis, MO; Engenia, BASF Corporation, Research Triangle Park, NC) for over-the-top use in DR soybean and cotton was recently granted for certain states (Anonymous 2016a; Anonymous 2016b). Although a balanced preemergence (PRE) followed by postemergence (POST) herbicide program is recommended, dicamba applied in-crop will add an effective site of action to control problem broadleaf weeds in cotton and soybean (Byker et al. 2013; Flessner et al. 2015; Inman et al. 2016; Spaunhorst and Bradley 2013). However, research involving possible non-target effects of mixtures to be applied in this technology must be studied to examine any negative effects because of reports that dicamba off-target movement has occurred (Barber et al. 2017).

Low-rate exposure or spray tank contamination to non-DR soybean with dicamba can be highly injurious and possibly reduce yield (Auch and Arnold 1978; Boerboom 2004; Solomon and Bradley 2014; Wax et al. 1969; Weidenhamer et al. 1989). With the advent of DR cotton and soybean and approval for use of dicamba in-crop, there will be greater opportunity for damage to susceptible crops. Neighboring fields planted in conventional, glyphosate-resistant, or glufosinate-resistant soybean may be at high risk for injury if dicamba is applied. If sprayers are not properly cleaned following a dicamba application, subsequent spray applications to non-dicamba soybean are likewise expected to damage the crop (Boerboom 2004). Injury symptoms from dicamba exposure to soybean have been previously described mostly as leaf cupping, stem epinasty, and swelling of the stem (Al-Khatib and Peterson 1999; Andersen et al. 2004;

Sciumbato et al. 2004). In addition, pod malformation is a result of low doses of dicamba applied to soybean during reproductive stages (McCown et al. 2016b).

Historically, most dicamba applications occur in late winter or early spring for preplant removal of broadleaf vegetation prior to planting crops or in-crop to V3 to V5 corn, which is at a time when few soybean fields have emerged or emerged plants are in an early vegetative stage. Exposure to dicamba at vegetative stages may result in severe injury, but soybean often recovers from this injury by reproductive stages (Al-Khatib and Peterson 1999; Wax et al. 1969). Soybean compensates for terminal death by initiating branches from the cotyledon and unifoliate axils that reach a height comparable to nontreated plants (Wax et al 1969). These axillary branches produce flowers and pods to offset possible yield reduction from exposure to dicamba (Andersen et al. 2004; Weidenhamer et al. 1989). Therefore, injury resulting from dicamba in vegetative stages may not always result in yield reduction (Al-Khatib and Peterson 1999). Furthermore, the extent of injury may vary due to environmental conditions during and after application (Auch and Arnold 1978; Weidenhamer et al. 1989). Soybean exposed to dicamba when plants are drought stressed will be delayed in recovery when compared to plants experiencing adequate moisture levels (Auch and Arnold 1978; Weidenhamer et al. 1989). For these reasons, the extent of injury to vegetative soybean may not be a good predictor of yield loss because soybean has the ability to recover when exposed to good environmental conditions (Al-Khatib and Peterson 1999; Auch and Arnold 1978).

Applications of dicamba to DR soybean are allowed up to R1 growth stage; therefore, nearby non-DR soybean that are planted at similar dates will also be in reproductive stages (Anonymous 2016a; 2016b). Previous research has examined the effect of dicamba applied at low rates during reproductive development. Yield reduction of 20% required only 4 g ae ha^{-1} when applied at bloom, whereas 35 g ha^{-1} was required for the same yield reduction in vegetative stages (Wax et al. 1969). Furthermore, the dicamba applied at 11 g ha^{-1} at early bloom reduced yield 9 to 42% while not affecting yield at any other growth stage (Auch and Arnold 1978). More recent research also supports the previous claims of Wax et al. (1969) and Auch and Arnold (1978), as they also documented greater yield reduction from dicamba at R2 compared to V3 applications when applied at the same rate (Robinson et al. 2013; Solomon and Bradley 2014). In other research, soybean was 2.5 times more sensitive to yield reduction at R1 growth stage when exposed to dicamba at 4.4 and 17.5 g ha^{-1} than when exposed to the same rates at V3/V4 (Griffin et al. 2013). Previous research may warrant the concern some have over dicamba applications near reproductive non-DR soybean as studies conducted reveal that yield loss is of more concern once soybean reaches flowering stages.

Due to the attempt to achieve broad-spectrum weed control of both grasses and broadleaf weeds in DR crops with a single application, it is likely that glyphosate will be added to the spray tank in most instances. In fact, a premix of dicamba plus glyphosate is being developed for use in DR crops (Roundup Xtend with VaporGrip, Monsanto Corporation, St. Louis, MO). Interactions have been documented concerning the addition of glyphosate to other herbicides in terms of soybean phytotoxicity and weed control. For instance, the addition of glyphosate at 1270 g ha^{-1} to dicamba at 5.6 g ha^{-1} applied at V7 growth stage to glyphosate-resistant/dicamba-sensitive soybean caused 30 to 35% injury compared to 27 to 28% injury when dicamba was applied alone at 2 wk after application (Kelley et al. 2005). Control of glyphosate-resistant tall waterhemp (*Amaranthus rudis* Sauer.) increased when glyphosate was mixed with dicamba (Spaunhorst and Bradley 2013). It was assumed that the effect seen in glyphosate-resistant soybean was because glyphosate slowed the metabolism of dicamba, increasing the intensity and duration of injury over dicamba alone (Kelley et al. 2005); however, no explanation was included in regards to waterhemp control by the tank mixture (Spaunhorst and Bradley 2013).

Dicamba-sensitive soybean exposed to low doses of dicamba at reproductive stages results in offspring that display dicamba-like injury symptoms soon after emergence (Barber et al. 2015; Thompson and Egli 1973). Conversely, for glyphosate, there is no effect on glyphosate-sensitive offspring when low doses of the herbicide are applied during reproductive development to parent plants (Norsworthy 2004). Again, the addition of glyphosate to dicamba increases leaf injury to glyphosate-resistant soybean over dicamba alone (Kelley et al. 2005); however, the effect of low doses of the mixture on offspring needs to be examined.

Previous research has documented glyphosate to be accumulated in bolls of cotton plants when exposed during reproductive growth (Pline et al. 2001); however, research pertaining to growth, maturity, and yield effects of low doses of dicamba plus glyphosate on non-glyphosate/non-DR soybean is limited and needs to be expanded to further to understand potential risks associated with using both herbicides as a mixture or premix in DR crops. Greater soybean yield loss and transmission of dicamba-like symptoms to offspring, have been associated with applications of low doses of dicamba during reproductive development (Auch and Arnold 1978; Barber et al. 2015; Solomon and Bradley 2014; Thompson and Egli 1973; Wax et al 1969). Therefore, an experiment was conducted to examine the effects of low doses of dicamba and glyphosate alone and in combination on non-dicamba/glyphosate-resistant soybean during reproductive development. Subsequently, seed collected from parent plants exposed to dicamba and glyphosate were evaluated to assess the impact of both herbicides alone and in combination on offspring.

Materials and Methods

Field Experiment. Experiments were planted to indeterminate growth habit glufosinate-resistant (glyphosate and dicamba sensitive) soybean on April 30, 2015, and May 4, 2016, at the Arkansas Agriculture Research and Extension Center (AAREC) in Fayetteville, Arkansas, and on May 14, 2016, at the Pine Tree Research Station (PTRS) near Colt, Arkansas. Indeterminate varieties were chosen because previous researchers have documented that the response to dicamba differs between indeterminate and determinate soybean varieties (McCown et al. 2016a). The soil series at PTRS was a Calhoun silt loam (fine-silty, mixed, active, thermic Typic Glossaqualfs) with a pH of 7.8 and 2.23% organic matter. Fields at AAREC were classified as Leaf silt loam (fine, mixed, active, thermic Typic Albaquults) with a pH of 6.1 and 1.75% organic matter. Trials were seeded at 345,800 seeds ha^{-1} with the intention of obtaining a population of 275,000 plants ha^{-1} given 80% germination. At PTRS, soybean was furrow-irrigated and plots at AAREC were irrigated with overhead lateral irrigation. Experiments were irrigated once weekly at 2.5 cm if less than 2.5 cm of rainfall occurred over a 7-d period. Other agronomic information pertaining to each location is provided in Table 1.

Weeds were controlled at the experimental sites with a PRE application of flumioxazin at 70 g ai ha^{-1} at planting followed by two POST applications of glufosinate at 530 g ai ha^{-1} (Liberty, Bayer Cropscience, Research Triangle Park, NC 27709) plus *S*-metolachlor (Dual Magnum, Syngenta Corporation, Greensboro, NC 27408) at 1,064 g ai ha^{-1} added to the first POST application. Treatments were arranged in a randomized complete block (RCB) design with four replications. Dicamba (Clarity, BASF Corporation, Research Triangle Park, NC 27709), glyphosate (Roundup PowerMax, Monsanto Co, St. Louis, MO 63146), or a mixture of the two herbicides was applied at 1/64X (dicamba at 8.75 g ae ha^{-1}, glyphosate at 13.44 g ae ha^{-1}) or 1/256X (dicamba at 2.19 g ha^{-1}, glyphosate at 3.36 g ha^{-1}) of the recommended rate (dicamba at 560 g ha^{-1}, glyphosate at 860 g ha^{-1}) for DR cotton and soybean. Nonionic surfactant was added at 1/64X or 1/256X the full rate of 0.25% v/v (Induce, Helena Chemical Co, Collierville, TN) to all dicamba-alone treatments, but not dicamba plus glyphosate treatments because the glyphosate product already contained an adjuvant. Treatments were mixed using serial dilution from a stock 1X rate, and applications were made on each variety at R1 (initial flower), R3 (initial pod set), and R5 (initial seed formation). All treatments were applied using a handheld boom and CO_2-pressurized backpack sprayer with an output of 143 L ha^{-1} at 270 kPa tipped with 110015 AIXR nozzles (TeeJet Technologies, Springfield, IL 62703). Only the center two rows of each four-row plot were treated. Plot sizes are available in Table 1.

At 2 and 4 wk after application, visual measurements of percent leaf malformation and percent pod malformation were recorded on a scale of 0 to 100%, with 100 being most severe. Canopy height was also recorded at 4 wk after application. At soybean maturity, height (cm) to the terminal of three representative plants was averaged, and final pod malformation ratings were taken. Plots were harvested using a small-plot combine, and soybean grain yield was adjusted to 13% moisture. Canopy height, terminal height, and yield were later converted to a percentage relative to the nontreated control. In addition, a sample of approximately 500 seed from each plot was stored at -10 C after harvest.

Greenhouse Experiment. Seed samples from the previous field experiments were evaluated in a greenhouse at the University of Arkansas Altheimer Laboratory in Fayetteville, Arkansas. Three experiments in total were completed using offspring from both years at AAREC and 2016 from PTRS. Twenty-five seed from each sample were planted at a 2-cm depth into 33- by 18- by 13-cm trays, which were filled with potting mix (Sun Gro Horticulture, Seba Beach, AB, Canada). Trays from each of the four replications were arranged in a RCB design in the greenhouse. The greenhouse was maintained at 32 C daytime and 22 C nighttime temperatures (± 3 C). Natural lighting was supplemented by a metal halide lighting system and set to a 16-h photoperiod. Plants were watered daily to maintain adequate moisture levels. Twenty-one days after planting (DAP), emergence (%), injury (0 to 100% with 0 being no injury and 100 being plant death relative the nontreated control), and number of plants injured were recorded for each tray. Plants were considered injured if they exhibited leaf cupping, leaf strapping, stem epinasty, or stunting, which are common symptoms of soybean exposed to dicamba (Al-Khatib and Peterson 1999; Andersen et al. 2004; Sciumbato et al. 2004). Additionally, plant vigor was rated on a 1 to 5 scale for each tray where was 1 = extremely low vigor (delayed and/or reduced emergence) and 5 = extremely high vigor (seedlings quickly emerged and exhibited normal growth). A standardized rating for vigor has yet to be realized, but the concept of vigor and its importance in crop development are well-accepted (Pollock and Roos 1972). Aboveground biomass was collected at 21 DAP, dried at 66 C for 7 days, and weighed. Percent reduction in biomass was calculated relative to the nontreated control.

Droplet Size Determination. Droplet sizes of all mixtures used in these studies were determined using a Sympatec Helos Vario KR particle size analyzer in a low speed wind tunnel testing at the University of Nebraska West Central Research and Extension Center in North Platte, NE. This system uses laser diffraction to determine droplet size and is accurate from 18 to 3500 microns. Treatments (DGA dicamba alone; glyphosate alone; and the mixture all at 1/64 and 1/256 the proposed use rates of 560 g ae ha^{-1} and 860 g ae ha^{-1}) were repeated three times, and an analysis of variance was performed to evaluate mean Dv50 (point where 50% of the droplets are of the reported size or smaller).

Statistical Analysis. Data from all field and greenhouse trials were subjected to an ANOVA procedure using JMP 12 Pro (SAS Institute, Cary, NC 27511). Site year and replication nested within site year were considered random effects. Soybean growth stage, herbicide treatment, and rate were considered fixed effects. Previous research has documented little to no response by soybean to low rates of glyphosate applied during reproductive development (Norsworthy 2004). In the current experiment, glyphosate treatments caused no response and were excluded from the analysis, thereby reducing the herbicide treatment factor level to two. All remaining data met the assumptions necessary for ANOVA. Main effects and interactions for all dependent variables were assessed. Means were separated using Fisher's protected least significant difference (LSD) test (α=0.05).

Results and Discussion

Soybean Response to Dicamba during Reproductive Development. At 14 d after application (DAA), leaf malformation averaged across rate and timing was greater when glyphosate was added to dicamba (8%) compared to dicamba alone (6%). Applications occurring at R1 growth stage caused more leaf malformation than later timings ($p = 0.012$) (Table 2). In addition, degree of leaf malformation increased with rate; the high rate (dicamba at 8.75 g ha^{-1} alone and with glyphosate at 13.44 g ha^{-1}) produced a 5% increase in leaf malformation compared to the low rate (dicamba at 2.19 g ha^{-1} alone and with glyphosate at 3.36 g ha^{-1}) at this stage when rated 14 DAA. At 28 DAA, an interaction between herbicide and timing was observed ($p = 0.0425$). When applications were made at the R3 and R5 stages, leaf malformation 28 DAA was similar for dicamba alone and dicamba plus glyphosate. However, at 28 DAA of the R1 treatments, addition of glyphosate to dicamba produced a significant 6% increase in leaf malformation compared to dicamba alone. The reason for lack of an effect from glyphosate addition to dicamba at R3 and R5 may be because vegetative growth of soybean has nearly ceased by these stages of development due to floral induction (Heatherly and Elmore 2004). Conversely, during the early stages of reproductive development, soybean is still extending nodes and leaves as floral induction is postponed with indeterminate cultivars (Heatherly and Elmore 2004).

Therefore, dicamba drift to soybean during these stages is more likely to cause leaf malformation than at later reproductive stages.

Visible leaf malformation (injury) resulting from dicamba at 8.75 g ha^{-1} (35%) was somewhat similar to that documented by Kelley et al. (2005) where 38% injury resulted from dicamba at 5.6 g ha^{-1} at 28 DAA during flowering. Solomon and Bradley (2014) observed 15% injury 28 d after treatment with dicamba at 2.8 g ha^{-1}, whereas the current study documented 23% injury at a comparable rate and timing. The extent of injury to soybean from dicamba is known to differ slightly between growth habits, as well as environmental conditions, irrigation practices, and rainfall prior to, during, and after application (Auch and Arnold 1978; McCown et al. 2016a; Wax et al. 1969; Weidenhamer et al. 1989).

In general, extent of leaf malformation decreased as application was delayed. These results are explained by examining soybean plants at each respective stage. During early reproductive stages (R1), vegetative growth is still occurring at a rapid pace under ideal conditions (Heatherly and Elmore 2004). However, once pod formation initiates (R3), vegetative growth slows significantly and nearly ceases once seed formation begins (R5). Therefore, it is not surprising that dicamba exposure to soybean resulted in much greater leaf malformation when plants were still undergoing vegetative growth.

Main effects of both rate ($p = 0.0014$) and timing ($p = 0.0001$) were observed at 14 DAA (Table 3). Pod malformation was 6% higher with the low rate than with the high rate, averaged over herbicide and timing. Applications at R3 resulted in the greatest pod malformation (11%). At 28 DAA of the R3 treatments, pod malformation increased with the addition of glyphosate to dicamba. Furthermore, pod malformation was also dependent on both rate and application timing. The greatest pod malformation (29%) was documented among treatments involving high rates at R3 growth stage. Little pod malformation was observed after R5 applications (2 to 5%).

At soybean maturity, pod malformation involved interactions of herbicide by timing and rate by timing ($p = 0.0033$; $p = <0.0001$). Pod malformation at soybean maturity resulting from application at R1 and R5 was similar. However, the addition of glyphosate to dicamba increased pod malformation by 10% when applied at R3 growth stage (Table 3). When averaged across herbicide, pod malformation was greatest after application of the high rate at R3 growth stage (47%). This timing by rate combination was significantly greater than the low rate at this timing (23%) as well as all other combinations.

Extent of pod malformation has not been quantified in previous research. However, pod malformation occurs following dicamba drift (Auch and Arnold 1978; Weidenhamer et al. 1989). In the present study, the greatest percentage of pod malformation followed applications to R3 soybean. The focus of soybean at the R3 growth stage is to initiate pod formation; therefore, exposure to dicamba will have the greatest possibility of generating severe pod malformation. Dicamba exposure to soybean at R1 caused severe leaf malformation; however, pod formation has not yet begun at this timing. Hence, soybean plants have time to recover from dicamba exposure, which may lead to a lower dicamba concentration in the plant before pod formation begins and consequently result in a lower percentage of malformed pods. By the time seed formation stages (R5-R6) are reached, pod formation has been completed in all but the top nodes of soybean plants. In the current study, pod malformation after a low dose of dicamba at R5 was minimal (0 to 5%) and only documented in the upper two to four nodes.

When averaged across rates, glyphosate alone did not reduce 28 DAA canopy or mature terminal height of soybean at any timing relative to the nontreated check at 28 DAA or maturity (Table 3). Canopy height at 28 DAA was reduced most by dicamba (24%) and dicamba plus glyphosate (26%) when applied at R1 growth stage (Table 3). Application of dicamba and dicamba plus glyphosate to soybean at R3 resulted in canopy height reductions of 14% and 10%, respectively. Application of herbicides at R5 did not reduce soybean canopy height compared to the nontreated check.

At soybean maturity, height to the terminal node displayed a main effect of rate and an interaction between herbicide and timing ($p = 0.0261$; $p = <0.0001$) (Table 3). The high rate of dicamba plus glyphosate (1/64X) reduced terminal height 14%, whereas the low rate of the combination (1/256X) caused a significantly lower reduction of 10%. When averaged across rates, dicamba and dicamba plus glyphosate applied at R1 reduced plant heights more than any other herbicide by timing combination. Dicamba and dicamba plus glyphosate applied at R3 were similar, with terminal height reductions of 12 and 14%, respectively. Canopy heights of plants treated at R5 were minimally affected by any treatment combination. In general, height reductions decreased as dicamba applications were delayed. This study suggests that dicamba exposure to soybean in early flowering stages results in the greatest height reduction among applications during reproductive development, as has been reported in other research (Auch and Arnold 1978; Solomon and Bradley 2014; Weidenhamer et al. 1989). The lack of height reductions at later stages is likely because soybean plants shift to pod and seed production and plants are already near maximum height.

Delay in maturity was minimal in the present study, with no treatment resulting in more than a 4-d delay in maturity (Table 3). The present study uses rates similar to ones used in previous studies, which showed comparable delays in soybean maturity occurring at these rates (Solomon and Bradley 2014; Wax et al. 1969). In other research, delays in soybean maturity increased with dicamba rate (Auch and Arnold 1978; Kelley et al. 2005; Wax et al. 1969). Auch and Arnold (1978) reported delays in soybean maturity to range from 3 to 19 days when dicamba at 11 to 56 g ha^{-1} was applied at reproductive stages. Comparable delays (4 to 24 d) were reported when 2 to 64 g ha^{-1} were applied in bloom stages (Wax et al. 1969).

Soybean grain yield reduction involved both herbicide by timing and rate by timing interactions ($p= <0.0001$; $p= 0.0087$) (Table 3). Glyphosate applications did not reduce yield at any timing compared to the nontreated control, which agrees with previous research by Norsworthy (2004) where glyphosate at 8 g ha^{-1} applied at R2 or R5 stages did not reduce yield. The greatest yield reductions were from dicamba alone or with glyphosate applied at R1 growth stage, which has been reported previously (Wax et al. 1969; Solomon and Bradley 2014; Auch and Arnold 1978). Yield reductions from R3 applications of dicamba (7%) and dicamba plus glyphosate (6%) were small but were greater than the nontreated check. Applications during seed fill (R5) did not reduce yield compared to the nontreated check. Yield reduction was present only in treatments where height reduction at maturity occurred. Soybean yield reduction following mature height reduction has been documented previously (Weidenhamer et al. 1989).

Effect of Soybean Exposure to Dicamba on Offspring. Emergence of soybean offspring was significant for the main effects of herbicide ($p= 0.003$) and rate ($p=0.0481$) (Table 4). Glyphosate added to dicamba had no effect on offspring emergence relative to dicamba alone; however, dicamba-containing treatments lowered emergence by as much as 3% compared to the nontreated check. Soybean emergence from plants treated with the lowest rate was 100%. High rates decreased emergence 2%, which is likely not of biological importance and would not be noticed at a commercial production scale. Ideal growing conditions in the greenhouse may have expedited seed emergence over less-than-ideal field environments. Previous research using higher rates of dicamba applied during reproductive development showed reductions in germination and emergence (Thompson and Egli 1973; Wax et al. 1969). Germination was not affected by rates similar to those used in this study; yet, Wax et al. (1969) reported that germination was reduced to 79 and 19% when 1/32 (17.5 g ha^{-1}) and 1/16 X (35 g ha^{-1}) rates were applied. Emergence was only 50% when dicamba at 30 g ha^{-1} was applied, and soybean offspring failed to emerge when dicamba at 220 g ha^{-1} was applied during flowering stages (Thompson and Egli 1973).

Soybean plants exposed to a low dose of dicamba at R5 growth stage were more likely to experience a high percentage of injured offspring; however, adding glyphosate to dicamba did not increase injury to the offspring (Table 5). A rate by timing interaction was observed, with the highest percentage of injured plants (96%) resulting from parent plants treated with the high rates of dicamba alone and including glyphosate applied at R5 growth stage ($p=0.0026$). The low rates applied at R5 reduced incidence of emerged soybean offspring injury (dicamba-like symptoms), but only to 81%. Applications of high and low rates at R3 resulted in 59 and 34% of offspring being malformed, respectively. No difference was observed in percentage of plants malformed between high and low rates applied at R1, and symptoms were less than other combinations of rate and timing.

Overall, percentage of plants malformed and the degree of leaf malformation increased as application to soybean was delayed (Table 5), likely because application at late reproductive stages allowed for more dicamba storage in the seed. Dicamba exposure during reproductive development may allow offspring emergence, but with many of the emerged plants having malformed leaves. If auxin-like symptomology arises in newly planted soybean fields, growers may have cause for concern. In severe cases, the auxin-like symptomology could be mistaken as drift or carryover of auxin herbicides, causing growers to blame neighbors or custom applicators.

Reductions in vigor generally increased with later applications for all treatments, except for glyphosate alone, which maintained vigor at all applications and rates (Table 6). The addition of glyphosate to dicamba did not significantly reduce soybean offspring vigor at any growth stage compared to dicamba alone. Vigor reduction to offspring from dicamba-containing solutions applied at R1 ranged from 11 to 12%, regardless of rate. Treatment with dicamba-containing solutions at R3 resulted in reduced vigor to offspring ranging from 15 to 20% but did not differ between rates.

Application of dicamba at seed fill (R5) had the greatest impact on offspring vigor (Table 6). Dicamba and dicamba plus glyphosate applications at the low rate caused 22 and 30% reductions in vigor. Vigor was reduced more from the high rate of dicamba-containing solutions applied at R5 than from any other treatment.

Reduction in soybean offspring biomass for glyphosate-alone treatments was minimal (0 to 6%) (Table 6). The addition of glyphosate to dicamba did not further decrease biomass. Dicamba and dicamba plus glyphosate treatments caused similar biomass reduction when applied at R1 and R3, with values ranging from 4 to 8%. Trends for this parameter generally followed vigor reductions, as the greatest offspring biomass reduction occurred from the R5 application. At this timing, the lowest rate of dicamba alone and dicamba plus glyphosate resulted in 9 and 14% reduction in offspring biomass. At the higher rate, application of dicamba alone led to a 34% reduction, and the addition of glyphosate reduced biomass to 36% of the untreated check.

These results document that dicamba exposure to soybean at R5 growth stage can decrease vigor of offspring by as much as half and biomass up to a third. Knowing that the rates used in these experiments will not always cause noticeable injury at R5 growth stage is worrisome concerning soybean seed production fields as drift or tank contamination during seed fill could go unnoticed. Furthermore, standard germination tests may not identify poor quality seed as dicamba-containing solutions only slightly reduced emergence (2 to 3%) in this study. Therefore, contaminated seed may not be identified and subsequently be distributed to growers.

Practical Implications. The addition of an alternative site of action will increase diversity in soybean and cotton weed control programs. However, the addition of a grass-controlling herbicide such as glyphosate must be included in dicamba-glyphosate-resistant cropping systems for broad-spectrum weed control. Yet, precautions must be taken to reduce the chance of off-target movement to susceptible crops. Research herein and previous research show that extremely low doses of dicamba are harmful to soybean growth, and effects may be transmitted to offspring (Wax et al. 1969; Thompson and Egli 1973; Auch and Arnold 1978). Increased leaf or pod malformation caused by glyphosate addition to dicamba will not further reduce yields over a comparable dose of dicamba alone. However, predicting soybean yield loss by visual injury may not be ideal in reproductive stages as models often overestimate yield loss (Egan et al. 2014).

The addition of glyphosate to dicamba may lead to increased leaf and pod malformation to soybean after drift occurs; yet, observations on offspring such as emergence, malformation, and biomass are similar to those of dicamba alone. To investigate possible differences in herbicide mixtures that may be causing the effect seen on soybean exposed to drift, droplet size analysis was performed at the University of Nebraska West Central Research and Extension Center in North Platte, NE. Droplet sizes of the herbicide treatments evaluated were not different (data not shown); therefore, droplet size played no role in the effects seen in parent plants. Further research must be completed to determine if glyphosate is aiding in the translocation of dicamba to cause the observed effect in parent plants. The addition of glyphosate to dicamba did numerically increase vigor and biomass reductions to offspring. However, these differences were not statistically significant in this study. This research does conclude that seed fill exposure of soybean to dicamba will lead to greater offspring reductions in vigor and biomass; therefore, further research completed during seed fill using additional rates of glyphosate and dicamba may detect significant differences.

Injury observed to parents from soybean exposure to low doses of dicamba at seed fill was minimal. Therefore, it may be possible that dicamba exposure to soybean could go unnoticed. An additional concern would be that dicamba exposure to seed production fields might go unnoticed and continue through the harvest, cleaning, and bagging processes. Identification of seed contaminated by dicamba may be difficult. Testing of seed for presence of dicamba through laboratory analysis could prove costly. These experiments document that germination and emergence may not be reduced when dicamba at 2.19 and 8.75 g ha^{-1} are applied in reproductive development. However, effects are seen in these plants after emergence. A reduction in biomass could in turn lead to the necessity for additional weed control measures as plants may be delayed in canopy formation. Additional training may be helpful for commercial applicators involved in DR cropping systems as not all are aware of the care that needs to be taken when applying dicamba (Bish and Bradley 2017). Dicamba application training is crucial in informing the uninformed to guard against economic loss incurred by growers not planting DR soybean, contingent upon physical drift being solely responsible for off-target damage.

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Table 1. Cultivars, plot sizes, planting dates and application dates for experiments conducted in Fayetteville and Pine Tree, Arkansas.

Location	Year	Cultivar	Herbicide technology	Plot size (m)	Planting date	Application dates		
						R1	R3	R5
Fayetteville	2015	Pioneer 95L01	LibertyLink	3.7 × 6.1	4/30/2015	7/6/2015	7/26/2015	8/12/2015
Fayetteville	2016	Pioneer 49T31	LibertyLink	3.7 × 7.6	5/4/2016	7/9/2016	7/22/2016	8/10/2016
Pine Tree	2016	Progeny 4814	LibertyLink	3.1 × 6.1	6/9/2015	7/20/2016	7/30/2015	8/24/2016

Table 2. Anova table for field experiments.

Variable	Source	DF	F Ratio	Prob > F
Leaf malformation at 14 DAA	Herbicide	1	4.8843	0.0292
	Rate	1	1.2465	0.2667
	Stage	2	93.8031	<.0001
	Herbicide*Rate	1	0.0239	0.8774
	Herbicide*Stage	2	2.9146	0.0586
	Rate*Stage	2	4.6141	0.012
	Herbicide*Rate*Stage	2	0.3747	0.6884
Pod malformation at 14 DAA	Herbicide	1	1.2483	0.2674
	Rate	1	11.041	0.0014
	Stage	2	10.3411	0.0001
	Herbicide*Rate	1	0.1771	0.6751
	Herbicide*Stage	2	0.0735	0.9292
	Rate*Stage	2	2.8476	0.0641
	Herbicide*Rate*Stage	2	0.0154	0.9848
Leaf malformation at 28 DAA	Herbicide	1	5.0993	0.0263
	Rate	1	6.3456	0.0135
	Stage	2	214.2049	<.0001
	Herbicide*Rate	1	0.0061	0.9381
	Herbicide*Stage	2	3.2709	0.0425
	Rate*Stage	2	12.6905	<.0001
	Herbicide*Rate*Stage	2	0.509	0.6028
Height at 28 DAA	Herbicide	2	25.5571	<.0001
	Rate	1	2.1996	0.1403
	Stage	2	38.297	<.0001
	Herbicide*Rate	2	0.5611	0.5719
	Herbicide*Stage	4	10.5466	<.0001
	Rate*Stage	2	0.5256	0.5924
	Herbicide*Rate*Stage	4	0.4598	0.7651
Height at maturity	Herbicide	2	36.2868	<.0001
	Rate	1	5.0302	0.0261
	Stage	2	65.5059	<.0001
	Herbicide*Rate	2	1.5975	0.2051
	Herbicide*Stage	4	17.0167	<.0001
	Rate*Stage	2	1.8015	0.1679
	Herbicide*Rate*Stage	4	0.3009	0.8771

Table 2 continued

Variable	Source	DF	F Ratio	Prob > F
Mature pod malformation	Herbicide	1	6.2233	0.014
	Rate	1	69.2643	<.0001
	Stage	2	198.0152	<.0001
	Herbicide*Rate	1	0.0281	0.8671
	Herbicide*Stage	2	5.9765	0.0033
	Rate*Stage	2	24.3828	<.0001
	Herbicide*Rate*Stage	2	0.8432	0.4328
Maturity delay	Herbicide	2	11.1277	<.0001
	Rate	1	0.1487	0.7005
	Stage	2	17.0815	<.0001
	Herbicide*Rate	2	0.1487	0.862
	Herbicide*Stage	4	5.62	0.0004
	Rate*Stage	2	1.5142	0.2242
	Herbicide*Rate*Stage	4	0.9953	0.413
Yield	Herbicide	2	8.3847	0.0003
	Rate	1	11.4513	0.0009
	Stage	2	22.8636	<.0001
	Herbicide*Rate	2	2.563	0.0798
	Herbicide*Stage	4	8.5739	<.0001
	Rate*Stage	2	4.8683	0.0087
	Herbicide*Rate*Stage	4	1.0891	0.3633

Abbreviations: DAA = days after application; DF = degrees of freedom

Table 3. Leaf malformation, pod malformation, height, maturity delay, and yield of soybean when exposed to dicamba and glyphosate applied at two rates during R1, R3, and R5 growth stages.[ab]

Treatment	Leaf malformation[c]		Pod malformation[c]		Relative height		Maturity delay	Relative yield
	14 DAA	28 DAA	28 DAA	Maturity	28 DAA	Maturity		
Herbicide × Timing	----------	----------	----------	%	----------	----------	d	%
glyphosate × R1	-	-	-	-	100 a	96 a	2 b	100 a
dicamba × R1	-	29 b	-	12 c	76 c	68 c	2 b	82 c
dicamba + glyphosate × R1	-	35 a	-	13 c	74 c	67 c	2 b	84 c
glyphosate × R3	-	-	-	-	100 a	98 a	1 b	98 ab
dicamba × R3	-	9 c	-	30 b	86 b	88 b	2 b	93 b
dicamba + glyphosate × R3	-	10 c	-	40 a	90 b	86 b	4 a	94 b
glyphosate × R5	-	-	-	-	101 a	95 a	1 b	98 ab
dicamba × R5	-	1 d	-	4 d	101 a	98 a	4 a	101 a
dicamba + glyphosate × R5	-	1 d	-	3 d	102 a	96 a	2 b	101 a
Rate × Timing								
1/256 X × R1	14 b	27 b	8 cd	10 d	-	-	-	94 b
1/64 X × R1	19 a	37 a	15 b	15 c	-	-	-	84 c
1/256 X × R3	8 c	10 c	12 bc	23 b	-	-	-	97 ab
1/64 X × R3	6 c	8 c	29 a	47 a	-	-	-	93 b
1/256 X × R5	< 1 d	1 d	2 e	2 e	-	-	-	100 a
1/64 X × R5	< 1 d	1 d	5 de	5 de	-	-	-	100 a

[a] Means followed by the same letter within a column are not significantly different using Fisher's protected LSD ($\alpha = 0.05$).

[b] A 1X rate of dicamba and glyphosate was 560 and 870 g ae ha^{-1}, respectively.

[c] Leaf and pod malformation averages for glyphosate-containing treatments were not included due to lack of soybean response.

Table 4. ANOVA table for greenhouse experiments.

Variable	Source	DF	F Ratio	Prob > F
Emergence (% of nontreated)	Herbicide	2	6.0073	0.003
	Rate	1	3.9618	0.0481
	Herbicide*Rate	2	0.5134	0.5993
	Timing	2	0.1064	0.8991
	Herbicide*Timing	4	0.7443	0.563
	Rate*Timing	2	1.7885	0.1702
	Herbicide*Rate*Timing	4	0.9508	0.436
Plants injured (%)	Herbicide	2	2.1202	0.1481
	Rate	1	21.1886	<.0001
	Herbicide*Rate	2	0.0788	0.7794
	Timing	2	213.8425	<.0001
	Herbicide*Timing	4	1.6643	0.1938
	Rate*Timing	2	6.2854	0.0026
	Herbicide*Rate*Timing	4	0.0795	0.9236
Injury (% of nontreated)	Herbicide	2	1.4364	0.2332
	Rate	1	31.9317	<.0001
	Herbicide*Rate	2	0.0549	0.8151
	Timing	2	134.2254	<.0001
	Herbicide*Timing	4	0.5748	0.5644
	Rate*Timing	2	20.9325	<.0001
	Herbicide*Rate*Timing	4	0.7616	0.4692
Vigor (1 to 5)	Herbicide	2	54.644	<.0001
	Rate	1	11.0772	0.0011
	Herbicide*Rate	2	1.9344	0.1475
	Timing	2	43.6453	<.0001
	Herbicide*Timing	4	10.9328	<.0001
	Rate*Timing	2	6.0258	0.0029
	Herbicide*Rate*Timing	4	3.986	0.004
Biomass (% of nontreated)	Herbicide	2	18.4657	<.0001
	Rate	1	17.8643	<.0001
	Herbicide*Rate	2	1.7145	0.183
	Timing	2	22.44	<.0001
	Herbicide*Timing	4	8.9446	<.0001
	Rate*Timing	2	6.8346	0.0014
	Herbicide*Rate*Timing	4	5.4281	0.0004

Abbreviations: DF = degrees of freedom

Table 5. Percentage of plants injured and intensity of leaf malformation documented in offspring whose parents were exposed to low rates of glyphosate and dicamba during reproductive development.[ab]

Rate × Timing	Plants injured [c]		Visible leaf malformation [c]	
	------------------------%		------------------------	
1/256 X × R1	15	e	4	d
1/64 X × R1	15	e	2	d
1/256 X × R3	34	d	4	d
1/64 X × R3	59	c	8	c
1/256 X × R5	81	b	13	b
1/64 X × R5	96	a	26	a

[a] Means followed by the same letter within a column are not statistically different using Fisher's protected LSD ($\alpha = 0.05$).

[b] A 1X rate of dicamba and glyphosate was 560 and 870 g ae ha^{-1}, respectively.

[c] Percentage of plants injured and visible leaf malformation ratings for glyphosate-only treatments were not included because no response was observed.

Table 6. Relative vigor and biomass reduction documented in offspring whose parents were exposed to low rates of glyphosate and dicamba during reproductive development. [a]

	Relative vigor reduction						Relative biomass reduction					
	1/256 of use rate[b]			1/64 of use rate[b]			1/256 of use rate[b]			1/64 of use rate[b]		
Herbicide	R1	R3	R5	R1	R3	R5	R1	R3	R5	R1	R3	R5
	% of non-treated											
Glyphosate	3a	3ab	7a-d	4abc	8a-e	3ab	0a	1ab	2ab	4ab	6abc	0a
Dicamba	11a-f	19fgh	22hi	12b-g	20gh	44j	9bc	2ab	9bc	5abc	8bc	34d
Dicamba + glyphosate	12c-g	15d-h	30i	11a-f	16e-h	50j	4ab	5ab	14c	6abc	5ab	36d

[a] Means followed by the same letter within relative vigor reduction and relative biomass reduction are not statistically different using Fisher's protected LSD ($\alpha = 0.05$).

[b] Fraction of full labeled rate (560 g ae ha^{-1} of dicamba and 870 g ae ha^{-1} of glyphosate).

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Chapter 4

Comparison of Off-target Movement from DGA and BAPMA Dicamba to Non-dicamba-resistant Soybean

Abstract

It is well established that dicamba can cause severe injury to non-dicamba-resistant soybean. The availability of dicamba-resistant soybean and cotton varieties, in conjunction with release of new dicamba formulations approved for over-the-top use in these crops occurred in 2016. Until this approval, use of dicamba was limited to a relatively small amount of corn acres in the summer months when temperatures are conducive for volatility. Hence, studies were conducted in 2015 and 2016 at the Northeast Research and Extension Center in Keiser, AR, to examine the primary and secondary movement of two dicamba formulations using non-dicamba-resistant soybean as a bio-indicator. Diglycolamine (DGA) and N,N-Bis-(3-aminopropyl) methylamine (BAPMA) dicamba were applied simultaneously at 560 g ae ha^{-1} in the center of two side-by-side 8-ha fields to vegetative glufosinate-resistant soybean. On the same day, a rate response experiment was established encompassing nine different dicamba rates of each formulation. Results from the rate response experiment indicate that soybean is equally sensitive to DGA and BAPMA dicamba. Six to eight hours after application of the large drift trial in 2015, a rain event occurred likely limiting volatility by incorporating some of the herbicide into the soil. As a result, secondary drift was less in 2015 than in 2016. However, minimal secondary injury (< 5%) occurred 12 m further into DGA dicamba plots in 2015. In 2016, secondary movement was decreased by 72 m when BAPMA dicamba was used compared to DGA dicamba.

Nomenclature: dicamba; soybean, *Glycine max* (L.) Merr.

Key words: Off-target movement, primary drift, secondary drift, volatility

Introduction

Cotton and soybean cultivars with resistance to the synthetic-auxin dicamba have been commercially launched and are now widely available for purchasing and planting by growers. This new biotech trait will allow dicamba to be sprayed postemergence (POST) over these crops, which will range from April through August in some areas of the country (USDA-NASS 2010). Dicamba provides excellent control of some key broadleaf weed species, including glyphosate-resistant horseweed [*Conyza canadensis* (L.) Cronq.] (Kruger et al. 2010) and giant ragweed (*Ambrosia trifida* L.) (Vink et al. 2012). Although in-crop applications of dicamba in dicamba-resistant (DR) soybean and cotton will not be as broad-spectrum as glyphosate once was, it will provide a new site of action to be used in these crops to improve weed control and guard against herbicide resistance if used responsibly. Yet, integrating a new site of action into a herbicide program may only delay herbicide resistance and integrating non-herbicidal options may provide the best insurance against herbicide resistance (Harker et al. 2017).

Dicamba is a member of the benzoic acid family of herbicides but more widely grouped as a synthetic auxin because it mimics indole acetic acid (Mithila et al. 2011). For over 50 years, dicamba has been used for broadleaf weed control in corn (*Zea mays* L.), small grains, and pastures. Despite over five decades of use, only two weeds, kochia (*Kochia scoparia* L. Schrad.) and prickly lettuce (*Latuca serriola* L. Lacse), have evolved resistance to dicamba in the United States (Heap 2017). As with other pesticides, dicamba may move off-target by primary (physical) drift at the time of application. Dicamba is also a volatile compound, and secondary (volatile) movement and injury to soybean via volatilization can occur (Behrens and Lueschen 1979; Egan and Mortensen 2012; Mueller et al. 2013). Early research documented the volatile component of dimethylamine (DMA) dicamba to be free dicamba acid (Behrens and Lueschen 1979).

Incorporation of dicamba into a POST dicamba-resistant (DR) soybean or cotton weed control program will enable its use to be expanded into summer months where temperatures may reach yearly maximums. As with other herbicides, volatility of dicamba increases with temperature (Grover 1975; Behrens and Lueschen 1979), which is a concern for growers making applications under warm conditions. Furthermore, when high temperature is paired with low humidity, volatile losses may increase as there is more opportunity for dicamba acid to convert to a gaseous state.

Early research reported that after application of the DMA salt of dicamba, volatilization can occur at least 3 days after application (Behrens and Lueschen 1979). However, dicamba at only 280 g ae ha^{-1} (half the current rate of 560 g ae ha^{-1} for DR crops) was used. Soybean injury was greatest for plants placed in the field the day of the application, and decreased the following 2 days as different sets of plants were exposed. Symptoms decreased as potted plants were placed further from the application area; yet, injury still occurred to soybean placed 60 m from the application. Furthermore, it is possible that soybean injury from volatile loss of dicamba could be increased both in intensity and distance from the application if dicamba is applied to a larger area as only a 30- by 30-m area was sprayed in this research.

Previous researchers have shown DGA dicamba to be less volatile than DMA dicamba under field conditions (Egan and Mortensen 2012; Mueller et al. 2013); albeit, recent research found DGA dicamba volatilizes for at least 3 days after application (Anonymous 2017). Air samplers documented a 50% decrease in detection of gaseous dicamba over plots that received DGA dicamba as opposed to the DMA formulation (Mueller et al. 2013). When using bioassay soybean plants to estimate the amount of dicamba leaving the application area via secondary drift, off-target movement was reduced by 94% when the DGA salt of dicamba was applied over the DMA salt (Egan and Mortensen 2012). Although injury to soybean from secondary drift of DGA dicamba was less than that of DMA dicamba, malformation was still noticed out to 20 m in multiple trials when treating only 335 m^2 (0.033 ha). Therefore, use of this formulation in DR crops may need to be accompanied by buffers on all sides of the application area to guard against off-target movement because secondary movement could cause damage to multiple sides of a field if winds shift direction within 3 days of application.

The most recently labeled dicamba formulations for use in DR soybean and cotton are thought to have reduced volatile losses; however, little published research has been compiled on these new formulated products. As of November 9, 2016, a DGA dicamba with an additive (XtendiMax with VaporGrip, Monsanto Company, St. Louis, MO) was approved for supplemental labeling for use in DR cotton and soybean in the United States (Anonymous 2016a). This formulation is a combination of the previously available diglycolamine (DGA) salt of dicamba and acetic acid as an additive that is said to reduce volatile loss by inhibiting formation of free dicamba acid (MacInnes 2017). Additionally, the N,N-Bis-(aminopropyl) methylamine (BAPMA) salt of dicamba (Engenia, BASF Corporation, Research Triangle Park, NC 27709) was granted supplemental registration at a later date (Anonymous 2016b). This salt of dicamba is also purported to have reduced volatility over previous forms (Westberg and Adams 2017).

Although BAPMA dicamba is purported to have decreased secondary loss via volatilization over previous forms, published field research documenting the lower risk of this formulation does not exist. Previous research aimed at comparing volatile losses from herbicides either used potted bioassay plants that were not experiencing field soil conditions, or sought to quantify by analytical methods only the amount of herbicide leaving the application area (Bauerle et al. 2015; Egan and Mortensen 2012; Sciumbato et al. 2004; Strachan et al. 2013). Furthermore, if the size of the application area directly correlates to the amount of volatile loss, commercial applications to larger fields may result in a greater amount of secondary injury to soybean than previously realized. Therefore, a field experiment was designed to examine possible differences between DGA and BAPMA dicamba after application using commercial application techniques.

Materials and Methods

Drift Experiments. Field experiments were conducted in 2015 and 2016 at the Northeast Research and Extension Center in Keiser, AR. Glufosinate-resistant soybean (Bayer Credenz 4950LL) was planted in two adjacent 8-ha fields on June 15, 2015, and June 13, 2016. Rows were bedded on 97-cm centers. Weed control was provided with preemergence (PRE) applications of flumioxazin at 71 g ai ha^{-1} plus paraquat at 701 g ai ha^{-1} and two POST applications of glufosinate at 595 g ai ha^{-1} plus clethodim at 76 g ai ha^{-1}. Furrow irrigation was used to supplement natural rainfall.

A 38- by 38-m area (0.144 ha) in the center of each field simultaneously received either DGA or BAPMA dicamba applied at 560 g ae ha^{-1} with one of two Bowman Mudmaster (Bowman Manufacturing, Newport, AR, 72112) high-clearance sprayers. Applications were made at soybean V6/V7 in 2015 and V4/V5 growth stage in 2016. Each sprayer was equipped with a broadcast boom having a 7.6-m swath tipped with 11003 TTI nozzles (TeeJet Technologies, Springfield, IL) calibrated to deliver 94 L ha^{-1} at 275 kPa while traveling at 15 km h^{-1}. Five passes were made, with each sprayer (one for each formulation) simultaneously applying the herbicide to reduce variation in wind, humidity, and temperature. Wind speeds were recorded at 1-s intervals during the application. Relative humidity and temperature were recorded at the beginning and end of the application. Daily weather data (wind speed, wind direction, temperature, humidity) on a 15-s interval were recorded from 1 week before application to 3 weeks after application using a weather station placed between the two fields.

Prior to application, transects were laid out in each of the eight cardinal directions extending to the edge of the field. Plots were established every 3 m from 3 to 12 m from the sprayed area, every 6 m from 12 to 36 m, every 9 m from 36 to 72 m, and every 12 m beyond 72 m until the edge of the field was reached. Two subplots consisting of four to five soybean plants per subplot were marked at each distance. The subplots consisted of soybean plants that were exposed to a) primary plus secondary drift or b) secondary drift only (any exposure more than 30 min after application). Immediately before application, 19-L buckets were placed over the soybean plants in subplots that were exposed only to secondary drift. Buckets were removed from these plants 30 minutes after completing the spray application (secondary drift only). The primary plus secondary drift subplot was never covered.

Additionally, metal rebar stands were erected with a 20 by 20 cm plywood platform affixed to the rebar at the height of the soybean canopy just before spraying. These stands were placed within the treated area and at each plot in 2015. In 2016, stands were again placed in the treated area but only in plots up to 30 m from the application. Four petri dishes (63 cm^2 in size) were placed on separate stands within the treated area to catch a full rate of dicamba. Mylar cards were placed on the stands outside of the treated area to catch primary drift. In 2015, 100 cm^2 mylar cards were placed on stands at 3, 6, 9, and 12 m from the application. Mylar cards 400 cm^2 in size were used at plots starting at 18 m to the field border. In 2016, 400 cm^2 mylar cards were used from 3 to 30 m. In order to quantify primary drift, rhodamine dye (Sigma-Aldrich Company, St. Louis, MO) was placed in each spray tank at 1 g L^{-1}. Mylar cards have been previously used as a means of catching herbicide drift (Salyani and Cromwell 1992; Yates et al. 1978). Petri dishes and mylar cards were removed from the field 30 min after application and placed in plastic bags indicating their location and then in a dark cooler to prevent photodegradation of the dye. Petri dishes and mylar cards were taken to the University of Nebraska Pesticide Application Laboratory in North Platte, NE, to quantify the amount of dye present on each surface using fluorimetry. A Turner Designs Trilogy 7200-000 (San Jose, CA) with green module and RTW/PE filter was used to analyze the samples. Samples were prepared by adding either 40 ml (Petri dishes and 100 cm^2 mylar cards) or 60 ml (400 cm^2 mylar cards) of distilled water and agitating to dissolve the rhodamine dye before extracting with a pipette and placing into 10- by 10-mm plastic cuvettes, which were placed in the fluorimeter for reading. Readings were given in relative fluorescence units (RFU) and later converted to ppm of rhodamine dye with use of a calibration curve. From ppm of rhodamine dye, concentrations could then be converted to amount of solution reaching each card, allowing calculation of the dicamba dose reaching each distance via primary movement.

Injury to soybean within each subplot (primary plus secondary, secondary) was rated at 7, 14, and 21 days after application (DAA). Injury was rated on a 0 to 100% scale with 100% being plant death. There was no attempt to solely quantify primary drift because this would have required plants be covered for several days with buckets as DGA dicamba is known to volatilize throughout this period (Anonymous 2017). Injury to soybean outside of the treated area was primarily in the form of leaf cupping, but also included leaf crinkling, epinasty, and terminal death (Andersen et al. 2004; Sciumbato et al. 2004). Two soybean plants exposed to primary plus secondary drift were harvested at 7 DAA in 2015 and four plants in 2016 directly adjacent to all distances that were rated for injury. Samples were transported on dry ice to the Arkansas State Plant Board in Little Rock, AR, and analyzed for dicamba remaining in the tissue. The method of dicamba extraction and quantification was GC/MS, similar to that reported previously (Andersen et al. 2004). The limit of detection was 1 ppb.

Analysis of Droplet Spectrum. BAPMA and DGA dicamba spray solutions similar those used in the field study were analyzed with a Sympatec Helos Vario KR particle size analyzer (Sympatec GmbH, Pulverhaus, Germany) with R7 lens installed in a low speed wind tunnel at 24 km h^{-1}. Droplets were detectable from 18 to 3500 microns. This equipment uses laser diffraction to determine particle size distribution, and the width of the spray pattern was analyzed by moving the nozzle across the laser with a linear actuator. A single TeeJet 11003 TTI nozzle was used with a pressure of 275 kPa.

Dose Response Experiment. Credenz 4950 was also planted on the same day as the large field experiment in a smaller field located approximately 1 km away for use as a DGA and BAPMA dicamba rate response experiment. Applications were made on the same day as the large field experiment. Row spacing, irrigation, and weed control measures were also the same as in the large field experiment. Ten dicamba doses (56, 17.5, 5.6, 1.75, 0.56, 0.175, 0.056, 0.0175, 0.0056, and 0.00175 g ae ha^{-1}) for each formulation were applied to the center two rows of each four-row plot using a CO_2-pressurized backpack sprayer with a 1.5-m spray boom equipped with four 110015 AIXR nozzles (TeeJet Technologies, Springfield, IL, 62703) with an output of 143 L ha^{-1} at 275 kPa. Treatments were arranged in a randomized complete block design and included four replications.

Injury ratings were taken 7, 14, and 21 DAA. Data were subjected to a two-way ANOVA to test for effects of rate, formulation, and the interaction between rate and formulation as related to injury at 21 DAA. Injury data were also subjected to regression analysis using Sigma Plot (Systat Software Inc., San Jose, CA) to determine goodness of fit based on r^2, AIC (Akaike information criterion), and BIC (Bayesian information criterion) values and significance of the regression ($\alpha < 0.05$). For each year, a model describing ln dose (g ae ha^{-1}) as a function of injury (%) at 21 DAA was produced. Models could then be applied to their respective years within the large drift experiment where observed injury could be paired with an estimated rate of dicamba in g ae ha^{-1} at that particular location within the field similar to that done previously (Egan and Mortensen 2012).

Similar to the large drift trial, whole plant tissue samples were collected 7 DAA (DGA salt only) and analyzed for the presence of dicamba. Plant heights were also collected 21 DAA and subjected non-linear regression analysis in Sigma Plot (Systat Software Inc., San Jose, CA). Various exponential models were tested and goodness of fit was decided based on r^2, AIC, and BIC values. Measures of AIC and BIC were used to compare across models with the lowest values indicating the best fit. Regression figures for the effect of dicamba dose on soybean height were produced using JMP Pro 12 (SAS Institute, Cary, NC).

Results and Discussion

Large Drift Experiment. Most volatility of dicamba occurs in the first 24 hours after application; however, volatility can occur for at least 3 days after application (Anonymous 2017; Behrens and Lueschen 1979; Mueller et al. 2013). No attempt was made to quantify primary drift injury because buckets placed on plants for this period would likely result in significant plant injury because of the hot conditions experienced the day of application. Therefore, only injury seen from secondary and primary plus secondary off-target movement of dicamba to soybean is discussed.

Ambient air temperature was 38 C in 2015 and 30 C in 2016 at the time of application whereas relative humidity was 44% in 2015 and 77% in 2016 (Table 1). Environmental conditions during application were a good representation of those likely for a POST herbicide applied to late-planted or double-crop soybean. Wind speed ranged from 4 to 12 km h^{-1} in 2015 and 10 to 16 km h^{-1} in 2016, conditions suitable for spraying based on the label for the BAPMA salt of dicamba in 2017 (Anonymous 2016b). Winds were primarily in a north/northeastern direction during and for 48 h after application both years (Figure 1); therefore, soybean injury was mainly confined to the north, northeast, and east transects (Tables 2 through 14); only transects having injury are presented in tables.

Injury resulting from primary plus secondary drift generally occurred along transects at further distances following application of the DGA than the BAPMA salt of dicamba in 2015 (Tables 2 through 6). In the 2015 experiment, the maximum distance to soybean injury via primary plus secondary drift was 45 m for DGA and 30 m for BAPMA, as indicated by an average 1% soybean injury in the DGA experiment at 21 DAA. Yet, this slight malformation may not be noticeable to the average grower. The distance to 5% injury was 30 m for DGA and 24 m for BAPMA.

Primary plus secondary drift of dicamba was detected at much greater distances in 2016, likely caused by wind speed being greater, as wind velocity is reported to have a linear relationship with drift of herbicide spray (Maybank et al. 1978) (Tables 7 through 14). Soybean injury via primary plus secondary drift occurred up to the field edge (over 180 m) with the DGA salt and extended to 108 m with the BAPMA salt. The maximum distance to 5% soybean injury of the DGA salt (120 m) was over twice as far as the BAPMA salt (54 m).

The droplet spectrum of a given nozzle may be dependent upon the mixture being applied (Meyer et al. 2015). Meyer et al. (2015) documented volume median diameter (VMD; the point at which 50% of the spray volume is below the given size) for a 1X rate of glufosinate (594 g ai ha^{-1}) to be 617 µm when applied through TTI 11006 nozzles at a pressure of 275 kPa. Using the same nozzle and pressure, VMD for a 1X rate of BAPMA dicamba (560 g ae ha^{-1}) was 756 µm. However, our results document the difference in VMD to be just 13 microns between DGA (757 µm) and BAPMA dicamba (744 µm). In addition, the percentage of fines (droplets < 210 µm) was equivalent for the two formulations (1.57% of total spray volume). Therefore, similar distance primary drift would be expected.

An attempt to measure primary drift using mylar cards resulted in only two positive readings in 2015 and nine positive readings in 2016. Use of mylar cards in combination with fluorimetry does not appear accurate enough to quantify the extremely low rates of primary dicamba drift capable of causing injury to soybean. Conversely, dicamba drift research in a wind tunnel using a 1,3,6,8-pyrenetetrasulfonic acid tetra-sodium salt (PTSA) fluorescent tracer in conjunction with 1.2 by 0.5-m polyethylene rugs to absorb droplets has provided better results (Alves et al. 2017a; 2017b). The confined system in combination with a larger surface area to collect droplets may be why the wind tunnel evaluations were more successful than field estimates of drift. Additionally, it may be possible that rhodamine dye was lost during the 30-min period following application. As shown in other research, rhodamine dye is sensitive to photo-degradation (Wu et al. 1998).

Weather conditions can drastically affect secondary off-target movement of dicamba with air temperature being positively correlated and humidity being negatively correlated with volatility (Behrens and Lueschen 1979; Mueller et al. 2013). Higher temperature accompanied with low humidity in 2015 would likely lead to greater volatile loss than the moderate temperature and humidity level that occurred at application in 2016. However, secondary movement was less in 2015 when compared to 2016. A 7-mm rain event 8 hours following application in 2015 likely caused some dicamba to be washed from soybean leaves and incorporated into soil, greatly reducing subsequent volatility (Behrens and Leuschen 1979). As a result, secondary injury was observed only out to 24 m with the DGA salt and 12 m with the BAPMA salt in 2015. The 2016 experiment led to secondary injury out to 180 m with the DGA salt and 108 m with the BAPMA salt. No precipitation occurred for 3 days following the 2016 experiment.

Rate Response Experiment. A two-parameter exponential model was fit to the soybean height data both years (Figures 2 and 3; Table 15). The curve for 2016 was much steeper than 2015, and the highest dicamba rates produced nearly twice the height reduction in 2016.

Soybean injury in the rate response experiment mirrored that of the large drift experiments in that malformation was much greater in 2016 than 2015 (Figures 4 and 5). Again, it is thought that either environmental conditions around the time of application or the unexpected rainfall after application caused such differences. Soybean injury reached a maximum at 21 DAA; therefore, this measure was used in all evaluations.

There was no significant difference between formulations and no interaction between formulation and rate in either year; therefore, data were pooled over formulations each year. Previous research has established similar findings regarding DMA and DGA salts of dicamba

(Egan and Mortensen 2012). In both years, a quadratic model described the relationship between soybean injury and rate applied. Models for each respective year were used to estimate an approximate dose of dicamba received in plots of the large drift experiment. The results are presented in Tables 2 through 14.

The amount of dicamba estimated to reach subplots as calculated by injury from the rate response experiment was numerically greater for DGA than for BAPMA both years. This may be due to the volatile component being less for BAPMA dicamba or the heavier weight resulting in a greater settling velocity. In 2016, estimations of injury were also greater, and damage extended further from the area applied for both herbicides.

Analytical Detection of Dicamba. Overall, results from analytical detection of dicamba in soybean tissue were variable (Table 16). Dicamba was recovered in greater quantities in 2016 than 2015. In 2015, only seven plots from the rate titration experiment tested positive for dicamba, and no plants treated with dicamba lower than 5.6 g ha^{-1} tested positive for dicamba. In 2016, dicamba was detected at rates as low as 1.75 g ha^{-1}. It could be that the 7 mm rainfall event approximately 6 hours after application in 2015 affected dicamba adsorption. Information in the literature is limited on absorption of dicamba in soybean; however, some research exists in weed species. One such article documented that ^{14}C uptake of dicamba only reached 47 and 33% of that applied at 7 days after application to resistant and susceptible kochia (*Kochia scoparia* L. Schrad.), respectively (Cranston et al. 2001). At one day after application, both were reported to adsorb less than 15% of the ^{14}C dicamba applied. Assuming that adsorption of dicamba is somewhat similar between kochia and soybean, it is likely that some dicamba was washed from leaf surfaces and allowed to either volatilize or move to the soil and result in less total dicamba plant adsorption in 2015.

Similar injury ratings were documented between the large drift and rate response experiments. However, dicamba was recovered at greater concentrations in the rate response experiment (Figures 6 and 7). More uniform coverage and a higher spray volume in the rate response experiment could have led to greater uptake of dicamba. More volatilization likely occurred in the large drift experiments than in rate titration experiments because the amount of dicamba applied was greater. Additionally, it is possible that dicamba uptake from primary deposition is not equal to that of gaseous entry of the herbicide. However, an assumption made in other research was that injury to soybean from low-rate direct applications is comparable to injury from volatilization (Egan and Mortensen 2012). No literature is available comparing the two forms of uptake at present. Gas exchange allowing uptake of volatile dicamba may be occurring at a higher rate than adsorption of dicamba salt through cuticular waxes and membranes, which could further complicate research pertaining to off-target movement of dicamba.

Even in plots having 25 to 40% injury, the presence of dicamba could not always be detected in the soybean tissue, meaning that individuals collecting tissue following observed injury caused by dicamba may obtain a false negative (plants showing symptoms with no dicamba analytically detected) from an analytical report (Figures 6 and 7). The variability in data along with false negatives seem to indicate that visible injury ratings may detect dicamba more accurately and efficiently than the analytical methods employed in this experiment. Previous research by Andersen et al. (2004) also attempted to recover dicamba residue from soybean foliage. Their research proposes that dicamba is either translocated to roots or is metabolized by aboveground meristematic tissue as the ability to recover dicamba from foliage diminished rapidly over time. Other research documented 10 and 64.5% of 5-OH dicamba (dicamba metabolite) was found in the treated leaf of susceptible and resistant kochia, respectively, at 7 days after application of ^{14}C dicamba (Cranston et al. 2001).

Practical Implications. Results from the rate response study indicate that soybean is equally sensitive to dicamba formulations containing the DGA or BAPMA salts when exposed to low rates at vegetative stages. In other research, Egan and Mortensen (2012) found no difference in soybean sensitivity between dicamba formulations of DGA and DMA salts. However, the distance to soybean having 5% secondary injury was reduced by half in the BAPMA large drift experiment in 2016. Hence, BAPMA dicamba may be a more responsible choice for application in DR soybean and cotton. Yet it must be noted that in 2016 BAPMA dicamba moved 108 m (1% injury) via secondary drift and was documented to cause 5% injury at 63 m from only a 1,444 m^2 (0.14 ha) application area. With use of BAPMA dicamba in DR-crops, application areas will increase. It is likely that secondary movement of dicamba will also increase at a proportional rate, causing injury to nearby non-DR soybean. Our research could also be a best-case scenario, in that previous research has shown volatile loss of dicamba to be increased after it contacts soybean foliage than when it is deposited on a silt loam soil (Behrens and Lueschen 1979). Hence, if a dicamba application is delayed to a late vegetative stage when more foliage exists, volatile loss and subsequent secondary drift could be magnified.

A larger area was injured in 2016 than in 2015. The reduced injury in 2015 could be due to the rain event shortly after application. The rainfall likely did not allow time for adequate adsorption of dicamba and reduced subsequent volatilization, essentially resulting in plants being exposed to lower rates of dicamba in 2015. Even more compounding is the timing of POST herbicide application in these trials. In 2015, POST applications of glufosinate were made one week after initiation of the drift event. However, in 2016 a POST glufosinate application was made 3 days prior to the drift event. Previous research has documented that some herbicides may increase soybean injury incurred from dicamba when applied simultaneously (Kelley et al. 2005). Additionally, unabsorbed glufosinate on the leaf surface could potentially cause enhanced dicamba volatilization as seen in other research where dicamba volatility increased when mixed with dicamba (Norsworthy 2017, unpublished data).

Based on the dicamba residue results, it does not appear likely that the analytical methods employed are sufficient for detecting dicamba in soybean, even when tissue samples are collected as early as 7 days after a drift event. The fact that dicamba cannot be easily detected using analytical techniques may be extremely important when trying to determine the actual auxin herbicide responsible for injury to soybean, especially when multiple auxin herbicides are used for preplant and in-crop applications in an array of crops.

Primary drift may be adequately mitigated by use of downwind buffers and application practices, but secondary drift is not easily resolved. With primary drift, wind direction during application provides insight into risk for injury to susceptible crops in the downwind direction; however, injury from secondary movement resulting from changes in wind direction following application poses a risk that is difficult to account for during the application. Ultimately, a single-direction buffer may be adequate for primary drift; however, multi-directional buffers are necessary to protect non-DR soybean and other sensitive vegetation from secondary drift.

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Table 1. Weather conditions during and after application of DGA and BAPMA dicamba in 2015 and 2016 at Keiser, AR.[a,b]

Time period	Rainfall		Min. /max. air temperature		Min. /max. relative humidity	
	2015	2016	2015	2016	2015	2016
	--mm--		------C------		------%------	
During application	--	--	38	31	45	77
Day of application	7	0	23/38	27/31	44/87	65/83
One day after application	3	0	23/30	24/32	62/91	58/89
Two days after application	22	0	22/29	24/33	65/94	53/91
Three days after application	2	0	23/30	22/30	60/93	62/91

[a]Abbreviations: DGA, diglycolamine salt of dicamba; BAPMA, N,N-Bis-(aminopropyl) methylamine salt of dicamba; min, minimum; max, maximum

[b] Average/maximum wind speed during application was 8/12 and 12/16 km h^{-1} in 2015 and 2016, respectively. During application wind was in the N direction in 2015 and in the NNE direction in 2016. See Figure 1 for average wind speed and direction following application.

Table 2. Injury to soybean, estimated dose of DGA and BAPMA dicamba, DGA dicamba detected in soybean, and dicamba detected on mylar cards along the north transect in 2015 at Keiser, AR.[ab]

	DGA					BAPMA			
	Injury[c]					Injury[c]			
Distance[g]	Primary + Secondary	Secondary	Estimated dose[d]	Foliar residue[e]	Mylar residue[f]	Primary + Secondary	Secondary	Estimated dose[d]	Mylar residue[f]
m	---------%---------		g ae ha^{-1}	--------ppb--------		---------%---------		g ae ha^{-1}	ppb
3	45	20	30.994	12	0	35	15	19.248	0
6	35	15	19.248	10	0	30	10	12.287	0
9	25	5	6.816	14	0	30	7	12.287	0
12	20	5	3.286	0	0	25	5	6.816	0
18	15	0	1.376	0	0	12	0	0.764	0
24	8	0	0.322	14	0	5	0	0.159	0
30	7	0	0.255	0	0	1	0	0.057	0
36	1	0	0.057	0	0	0	0	0	0

[a]Abbreviations: DGA, diglycolamine form of dicamba; BAPMA, N,N-Bis-(aminopropyl) methylamine form of dicamba

[b]Wind direction during application ranged between NNE and NNW with an average of 8 and max of 12 km h^{-1}

[c]Plant injury rated on a 0 to 100% scale with 100% being plant death

[d]Dose estimated using equations generated from rate titration trial injury levels

[e]The limit for detecting dicamba was 1 ppb

[f]The estimated amount of dicamba collected from mylar cards placed within plots for measuring physical drift from 0 to 30 minutes after application

[g]Distances where no injury was observed are not shown

Table 3. Injury to soybean, estimated dose of DGA and BAPMA dicamba, and DGA dicamba detected in soybean along the northeast transect in 2015 at Keiser, AR.[ab]

	DGA					BAPMA			
	Injury[c]					Injury[c]			
Distance[g]	Primary + Secondary	Secondary	Estimated dose[d]	Foliar residue[e]	Mylar residue[f]	Primary + Secondary	Secondary	Estimated dose[d]	Mylar residue[f]
m	---------%---------		g ae ha^{-1}	--------ppb--------		---------%---------		g ae ha^{-1}	ppb
3	40	8	0.096	14	0	25	10	6.816	0
6	30	5	12.287	8	0	20	8	3.286	0
9	20	5	3.286	0	57	18	5	2.359	0
12	10	2	0.501	8	0	15	2	1.376	0
18	7	1	0.256	0	0	8	0	0.322	0
24	5	1	0.159	0	0	3	0	0.096	0
30	5	0	0.159	0	0	2	0	0.074	0
36	4	0	0.1238	0	0	0	0	0	0
45	1	0	0.057	0	0	0	0	0	0

[a]Abbreviations: DGA, diglycolamine form of dicamba; BAPMA, N,N-Bis-(aminopropyl) methylamine form of dicamba

[b]Wind direction during application ranged between NNE and NNW with an average of 8 and max of 12 km h^{-1}

[c]Plant injury rated on a 0 to 100% scale with 100% being plant death

[d]Dose estimated using equations generated from rate titration trial injury levels

[e]The limit for detecting dicamba was 1 ppb

[f]The estimated amount of dicamba collected from mylar cards placed within plots for measuring physical drift from 0 to 30 minutes after application

[g]Distances where no injury was observed are not shown

Table 4. Injury to soybean, estimated dose of DGA and BAPMA dicamba, and DGA dicamba detected in soybean along the east transect in 2015 at Keiser, AR.[ab]

	DGA					BAPMA			
	Injury[c]					Injury[c]			
Distance[g]	Primary + Secondary	Secondary	Estimated dose[d]	Foliar residue[e]	Mylar residue[f]	Primary + Secondary	Secondary	Estimated dose[d]	Mylar residue[f]
m	---------%---------		g ae ha^{-1}	--------ppb--------		---------%---------		g ae ha^{-1}	ppb
3	30	8	12.287	10	0	25	1	6.816	0
6	15	5	1.376	11	0	15	1	1.376	0
9	7	1	0.255	10	0	10	0	0.501	0
12	2	0	0.074	0	0	5	0	0.159	0
18	0	0	0	0	0	2	0	0.074	0

[a]Abbreviations: DGA, diglycolamine form of dicamba; BAPMA, N,N-Bis-(aminopropyl) methylamine form of dicamba

[b]Wind direction during application ranged between NNE and NNW with an average of 8 and max of 12 km h^{-1}

[c]Plant injury rated on a 0 to 100% scale with 100% being plant death

[d]Dose estimated using equations generated from rate titration trial injury levels

[e]The limit for detecting dicamba was 1 ppb

[f]The estimated amount of dicamba collected from mylar cards placed within plots for measuring physical drift from 0 to 30 minutes after application

[g]Distances where no injury was observed are not shown

Table 5. Injury to soybean, estimated dose of DGA and BAPMA dicamba, and DGA dicamba detected in soybean along the southeast transect in 2015 at Keiser, AR.[ab]

	DGA					BAPMA			
	Injury[c]					Injury[c]			
Distance[g]	Primary + Secondary	Secondary	Estimated dose[d]	Foliar residue[e]	Mylar residue[f]	Primary + Secondary	Secondary	Estimated dose[d]	Mylar residue[f]
m	---------%---------		g ae ha^{-1}	--------ppb--------		---------%---------		g ae ha^{-1}	ppb
3	0	0	0	0	0	2	0	0.074	0

[a]Abbreviations: DGA, diglycolamine form of dicamba; BAPMA, N,N-Bis-(aminopropyl) methylamine form of dicamba

[b]Wind direction during application ranged between NNE and NNW with an average of 8 and max of 12 km h^{-1}

[c]Plant injury rated on a 0 to 100% scale with 100% being plant death

[d]Dose estimated using equations generated from rate titration trial injury levels

[e]The limit for detecting dicamba was 1 ppb

[f]The estimated amount of dicamba collected from mylar cards placed within plots for measuring physical drift from 0 to 30 minutes after application

[g]Distances where no injury was observed are not shown

Table 6. Injury to soybean, estimated dose of DGA and BAPMA dicamba, and DGA dicamba detected in soybean along the south transect in 2015 at Keiser, AR.[ab]

	DGA					BAPMA			
	Injury[c]					Injury[c]			
Distance[g]	Primary + Secondary	Secondary	Estimated dose[d]	Foliar residue[e]	Mylar residue[f]	Primary + Secondary	Secondary	Estimated dose[d]	Mylar residue[f]
m	---------%---------		g ae ha^{-1}	--------ppb--------		---------%---------		g ae ha^{-1}	ppb
3	45	45	30.994	880	0	1	1	0.057	78592
6	15	0	1.376	13	0	0	0	0	0
9	0	0	0	19	0	0	0	0	0
12	0	0	0	21	0	0	0	0	0

[a]Abbreviations: DGA, diglycolamine form of dicamba; BAPMA, N,N-Bis-(aminopropyl) methylamine form of dicamba

[b]Wind direction during application ranged between NNE and NNW with an average of 8 and max of 12 km h^{-1}

[c]Plant injury rated on a 0 to 100% scale with 100% being plant death

[d]Dose estimated using equations generated from rate titration trial injury levels

[e]The limit for detecting dicamba was 1 ppb

[f]The estimated amount of dicamba collected from mylar cards placed within plots for measuring physical drift from 0 to 30 minutes after application

[g]Distances where no injury was observed are not shown

Table 7. Injury to soybean, estimated dose of DGA and BAPMA dicamba, and DGA dicamba detected in soybean along the north transect in 2016 at Keiser, AR.[ab]

	DGA					BAPMA			
	Injury[c]					Injury[c]			
Distance[g]	Primary + Secondary	Secondary	Estimated dose[d]	Foliar residue[e]	Mylar residue[f]	Primary + Secondary	Secondary	Estimated dose[d]	Mylar residue[f]
m	---------%---------		g ae ha^{-1}	--------ppb--------		---------%---------		g ae ha^{-1}	ppb
3	55	40	17.292	131	1,658	55	50	17.292	2,739
6	60	45	24.818	44	0	60	50	24.818	0
9	45	40	6.995	0	0	65	40	33.521	0
12	50	40	11.338	17	0	48	40	9.415	0
18	45	35	6.995	0	0	40	32	4.062	0
24	35	30	2.22	0	0	40	40	4.062	0
30	25	15	0.552	0	0	28	15	0.86	0
36	20	15	0.252	0	2,930	20	10	0.252	0
45	20	15	0.252	0	-	15	8	0.108	-
54	15	10	0.108	0	-	10	5	0.043	-
63	10	5	0.043	0	-	5	3	0.017	-
72	8	7	0.03	0	-	5	2	0.017	-
84	7	5	0.024	0	-	5	2	0.017	-
96	7	5	0.024	0	-	5	1	0.017	-
108	8	4	0.03	0	-	3	1	0.011	-
120	5	5	0.017	0	-	1	0	0.005	-
132	5	3	0.017	0	-	0	0	0	-
144	7	3	0.024	0	-	0	0	0	-
156	7	3	0.024	0	-	0	0	0	-

Table 7 continued

	DGA					BAPMA			
	Injury[c]		Estimated	Foliar	Mylar	Injury[c]		Estimated	Mylar
Distance[g]	Primary + Secondary	Secondary	dose[d]	residue[e]	residue[f]	Primary + Secondary	Secondary	dose[d]	residue[f]
168	5	3	0.017	0	-	0	0	0	-
180	2	1	0.008	0	-	0	0	0	-

[a]Abbreviations: DGA, diglycolamine form of dicamba; BAPMA, N,N-Bis-(aminopropyl) methylamine form of dicamba

[b]Wind direction during application ranged between NNE and NNW with an average of 8 and max of 12 km h^{-1}

[c]Plant injury rated on a 0 to 100% scale with 100% being plant death

[d]Dose estimated using equations generated from rate titration trial injury levels

[e]The limit for detecting dicamba was 1 ppb

[f]The estimated amount of dicamba collected from mylar cards placed within plots for measuring physical drift from 0 to 30 minutes after application

[g]Distances where no injury was observed are not shown

Table 8. Injury to soybean, estimated dose of DGA and BAPMA dicamba, and DGA dicamba detected in soybean along the northeast transect in 2016 at Keiser, AR.[ab]

	DGA					BAPMA			
	Injury[c]					Injury[c]			
Distance[g]	Primary + Secondary	Secondary	Estimated dose[d]	Foliar residue[e]	Mylar residue[f]	Primary + Secondary	Secondary	Estimated dose[d]	Mylar residue[f]
m	---------%---------		g ae ha^{-1}	--------ppb--------		---------%---------		g ae ha^{-1}	ppb
3	50	40	11.338	167	0	55	45	17.292	1,130
6	50	35	11.338	148	0	50	40	11.338	0
9	45	35	6.995	0	0	45	40	6.995	0
12	45	35	6.995	0	0	45	30	6.995	0
18	40	30	4.062	0	0	38	30	3.213	0
24	45	30	6.995	0	0	35	25	2.22	0
30	40	30	4.062	0	0	30	20	1.141	0
36	45	28	6.995	0	0	20	10	0.252	0
45	35	25	2.22	0	-	15	7	0.108	-
54	45	25	6.995	0	-	10	5	0.043	-
63	20	15	0.252	0	-	7	5	0.024	-
72	10	7	0.043	0	-	5	2	0.017	-
84	5	2	0.017	0	-	5	1	0.017	-
96	5	3	0.017	0	-	0	0	0	-
108	3	1	0.011	0	-	0	0	0	-

[a]Abbreviations: DGA, diglycolamine form of dicamba; BAPMA, N,N-Bis-(aminopropyl) methylamine form of dicamba

[b]Wind direction during application ranged between NNE and NNW with an average of 8 and max of 12 km h^{-1}

[c]Plant injury rated on a 0 to 100% scale with 100% being plant death

[d]Dose estimated using equations generated from rate titration trial injury levels

Table 8 continued

[e]The limit for detecting dicamba was 1 ppb
[f]The estimated amount of dicamba collected from mylar cards placed within plots for measuring physical drift from 0 to 30 minutes after application
[g]Distances where no injury was observed are not shown

Table 9. Injury to soybean, estimated dose of DGA and BAPMA dicamba, and DGA dicamba detected in soybean along the east transect in 2016 at Keiser, AR.[ab]

	DGA					BAPMA			
	Injury[c]					Injury[c]			
Distance[g]	Primary + Secondary	Secondary	Estimated dose[d]	Foliar residue[e]	Mylar residue[f]	Primary + Secondary	Secondary	Estimated dose[d]	Mylar residue[f]
m	---------%---------		g ae ha^{-1}	--------ppb--------		---------%---------		g ae ha^{-1}	ppb
3	45	35	6.995	167	1,280	45	38	6.995	0
6	50	38	11.338	29	0	55	38	17.292	0
9	45	38	6.995	0	0	50	38	11.338	0
12	28	20	0.86	0	0	35	25	2.22	0
18	25	18	0.552	0	0	25	15	0.552	0
24	15	10	0.108	0	0	25	15	0.552	0
30	20	5	0.252	0	0	25	10	0.552	0
36	10	5	0.043	0	0	15	8	0.108	0
45	8	4	0.03	0	-	5	1	0.017	-
54	10	5	0.043	0	-	3	1	0.011	-
63	8	5	0.03	0	-	0	0	0	-
72	5	2	0.017	0	-	0	0	0	-

[a]Abbreviations: DGA, diglycolamine form of dicamba; BAPMA, N,N-Bis-(aminopropyl) methylamine form of dicamba

[b]Wind direction during application ranged between NNE and NNW with an average of 8 and max of 12 km h^{-1}

[c]Plant injury rated on a 0 to 100% scale with 100% being plant death

[d]Dose estimated using equations generated from rate titration trial injury levels

[e]The limit for detecting dicamba was 1 ppb

[f]The estimated amount of dicamba collected from mylar cards placed within plots for measuring physical drift from 0 to 30 minutes after application

[g]Distances where no injury was observed are not shown

Table 10. Injury to soybean, estimated dose of DGA and BAPMA dicamba, and DGA dicamba detected in soybean along the southeast transect in 2016 at Keiser, AR.[ab]

	DGA					BAPMA			
	Injury[c]					Injury[c]			
Distance[g]	Primary + Secondary	Secondary	Estimated dose[d]	Foliar residue[e]	Mylar residue[f]	Primary + Secondary	Secondary	Estimated dose[d]	Mylar residue[f]
m	---------%---------		g ae ha^{-1}	--------ppb--------		---------%---------		g ae ha^{-1}	ppb
3	5	3	0.017	0	0	20	8	0.252	0
6	7	3	0.024	0	0	15	8	0.108	0
9	8	2	0.03	0	0	15	7	0.108	0
12	7	2	0.024	0	0	10	5	0.043	0
18	10	5	0.043	0	0	10	4	0.043	0
24	5	2	0.017	0	0	8	3	0.03	0
30	5	2	0.017	0	0	10	3	0.043	0
36	7	2	0.024	0	0	8	3	0.03	0
45	5	2	0.017	0	-	5	2	0.017	-
54	5	1	0.017	0	-	3	0	0.011	-
63	7	3	0.024	0	-	3	1	0.011	-
72	2	2	0.008	0	-	2	0	0.008	-
84	2	0	0.008	0	-	0	0	0	-

[a]Abbreviations: DGA, diglycolamine form of dicamba; BAPMA, N,N-Bis-(aminopropyl) methylamine form of dicamba

[b]Wind direction during application ranged between NNE and NNW with an average of 8 and max of 12 km h^{-1}

[c]Plant injury rated on a 0 to 100% scale with 100% being plant death

[d]Dose estimated using equations generated from rate titration trial injury levels

[e]The limit for detecting dicamba was 1 ppb

[f]The estimated amount of dicamba collected from mylar cards placed within plots for measuring physical drift from 0 to 30 minutes after application

[g]Distances where no injury was observed are not shown

Table 11. Injury to soybean, estimated dose of DGA and BAPMA dicamba, and DGA dicamba detected in soybean along the south transect in 2016 at Keiser, AR.[ab]

	DGA					BAPMA			
	Injury[c]					Injury[c]			
Distance[g]	Primary + Secondary	Secondary	Estimated dose[d]	Foliar residue[e]	Mylar residue[f]	Primary + Secondary	Secondary	Estimated dose[d]	Mylar residue[f]
m	---------%---------		g ae ha^{-1}	--------ppb--------		---------%---------		g ae ha^{-1}	ppb
3	20	15	0.252	0	0	20	10	0.252	0
6	10	10	0.043	0	0	10	5	0.043	0
9	7	2	0.024	0	0	8	3	0.03	0
12	5	2	0.017	0	4,095	3	1	0.011	159,180
18	7	4	0.024	0	0	2	0	0.008	0
24	5	1	0.017	0	0	5	0	0.017	0
30	2	1	0.008	0	0	2	0	0.008	0
36	2	2	0.008	0	0	2	1	0.008	0

[a]Abbreviations: DGA, diglycolamine form of dicamba; BAPMA, N,N-Bis-(aminopropyl) methylamine form of dicamba

[b]Wind direction during application ranged between NNE and NNW with an average of 8 and max of 12 km h^{-1}

[c]Plant injury rated on a 0 to 100% scale with 100% being plant death

[d]Dose estimated using equations generated from rate titration trial injury levels

[e]The limit for detecting dicamba was 1 ppb

[f]The estimated amount of dicamba collected from mylar cards placed within plots for measuring physical drift from 0 to 30 minutes after application

[g]Distances where no injury was observed are not shown

Table 12. Injury to soybean, estimated dose of DGA and BAPMA dicamba, and DGA dicamba detected in soybean along the southwest transect in 2016 at Keiser, AR.[ab]

	DGA					BAPMA			
	Injury[c]					Injury[c]			
Distance[g]	Primary + Secondary	Secondary	Estimated dose[d]	Foliar residue[e]	Mylar residue[f]	Primary + Secondary	Secondary	Estimated dose[d]	Mylar residue[f]
m	---------%---------		g ae ha^{-1}	--------ppb--------		---------%---------		g ae ha^{-1}	ppb
3	3	2	0.011	0	940	3	2	0.011	0
6	3	3	0.011	0	0	2	1	0.008	0
9	3	2	0.011	0	3,337	2	1	0.008	0
12	1	1	0.005	0	0	2	0	0.008	0
18	0	0	0	0	0	1	0	0.005	0

[a]Abbreviations: DGA, diglycolamine form of dicamba; BAPMA, N,N-Bis-(aminopropyl) methylamine form of dicamba

[b]Wind direction during application ranged between NNE and NNW with an average of 8 and max of 12 km h^{-1}

[c]Plant injury rated on a 0 to 100% scale with 100% being plant death

[d]Dose estimated using equations generated from rate titration trial injury levels

[e]The limit for detecting dicamba was 1 ppb

[f]The estimated amount of dicamba collected from mylar cards placed within plots for measuring physical drift from 0 to 30 minutes after application

[g]Distances where no injury was observed are not shown

Table 13. Injury to soybean, estimated dose of DGA and BAPMA dicamba, and DGA dicamba detected in soybean along the west transect in 2016 at Keiser, AR.[ab]

	DGA					BAPMA			
	Injury[c]					Injury[c]			
Distance[g]	Primary + Secondary	Secondary	Estimated dose[d]	Foliar residue[e]	Mylar residue[f]	Primary + Secondary	Secondary	Estimated dose[d]	Mylar residue[f]
m	---------%---------		g ae ha^{-1}	--------ppb--------		---------%---------		g ae ha^{-1}	ppb
3	10	10	0.043	0	0	15	7	0.108	0
6	7	5	0.024	0	0	10	7	0.043	0
9	5	5	0.017	0	0	5	2	0.017	0
12	3	3	0.011	0	0	5	2	0.017	0
18	0	0	0	0	0	2	1	0.008	0
24	0	0	0	0	0	3	1	0.011	0
30	0	0	0	0	0	2	0	0.008	0

[a]Abbreviations: DGA, diglycolamine form of dicamba; BAPMA, N,N-Bis-(aminopropyl) methylamine form of dicamba

[b]Wind direction during application ranged between NNE and NNW with an average of 8 and max of 12 km h^{-1}

[c]Plant injury rated on a 0 to 100% scale with 100% being plant death

[d]Dose estimated using equations generated from rate titration trial injury levels

[e]The limit for detecting dicamba was 1 ppb

[f]The estimated amount of dicamba collected from mylar cards placed within plots for measuring physical drift from 0 to 30 minutes after application

[g]Distances where no injury was observed are not shown

Table 14. Injury to soybean, estimated dose of DGA and BAPMA dicamba, and DGA dicamba detected in soybean along the northwest transect in 2016 at Keiser, AR.[ab]

	DGA					BAPMA			
	Injury[c]					Injury[c]			
Distance[g]	Primary + Secondary	Secondary	Estimated dose[d]	Foliar residue[e]	Mylar residue[f]	Primary + Secondary	Secondary	Estimated dose[d]	Mylar residue[f]
m	---------%---------		g ae ha^{-1}	--------ppb--------		---------%---------		g ae ha^{-1}	ppb
3	5	2	0.017	0	0	18	10	0.181	0
6	3	3	0.011	0	0	15	8	0.108	0
9	1	1	0.005	0	0	10	7	0.043	0
12	1	1	0.005	0	0	10	5	0.043	0
18	5	2	0.017	0	0	5	2	0.017	0
24	3	1	0.011	0	0	5	1	0.017	0
30	1	1	0.005	0	0	3	1	0.011	0
36	2	1	0.008	0	0	2	0	0.008	0
45	2	2	0.008	0	-	1	1	0.005	-
54	1	1	0.005	0	-	0	0	0	-

[a]Abbreviations: DGA, diglycolamine form of dicamba; BAPMA, N,N-Bis-(aminopropyl) methylamine form of dicamba

[b]Wind direction during application ranged between NNE and NNW with an average of 8 and max of 12 km h^{-1}

[c]Plant injury rated on a 0 to 100% scale with 100% being plant death

[d]Dose estimated using equations generated from rate titration trial injury levels

[e]The limit for detecting dicamba was 1 ppb

[f]The estimated amount of dicamba collected from mylar cards placed within plots for measuring physical drift from 0 to 30 minutes after application

[g]Distances where no injury was observed are not shown

Table 15. Nonlinear regression parameter estimates, standard error, and confidence intervals for the 2015 and 2016 relationship between soybean injury at 21 days after application and dicamba dose.[a]

Parameter	Estimate		Standard error		Confidence interval			
					2015		2016	
	2015	2016	2015	2016	Lower 95%	Upper 95%	Lower 95%	Upper 95%
Intercept (a)	-3.133	-5.220	0.197	0.239	-3.520	-2.747	-5.689	-4.750
Linear (b)	0.272	0.210	0.034	0.015	0.206	0.339	0.180	0.240
Quadratic (c)	-0.003	-0.001	0.001	0.000	-0.004	-0.001	-0.002	-0.001

[a]A three-parameter exponential model was used

Table 16. Mean, standard deviation, standard error, and 95% confidence intervals for dicamba recovered in soybean tissue at each respective rate applied in 2015 and 2016 at Keiser, AR.[a]

	Mean		Standard error		95% confidence intervals			
					Upper	Lower	Upper	Lower
Rate	2015	2016	2015	2016	2015	2016	2015	2016
g ae ha^{-1}	----	----	----	----	ppb	----	----	----
0.0175	0	0	0	0	0	0	0	0
0.056	0	0	0	0	0	0	0	0
0.175	0	0	0	0	0	0	0	0
0.56	0	0	0	0	0	0	0	0
1.75	0	40	0	31	0	0	138	58
5.6	4	8	2	8	11	-3	31	16
17.5	12	250	6	137	39	-16	685	185
56	61	1,595	29	378	185	-63	2,798	392

[a]The limit for detecting dicamba was 1 ppb

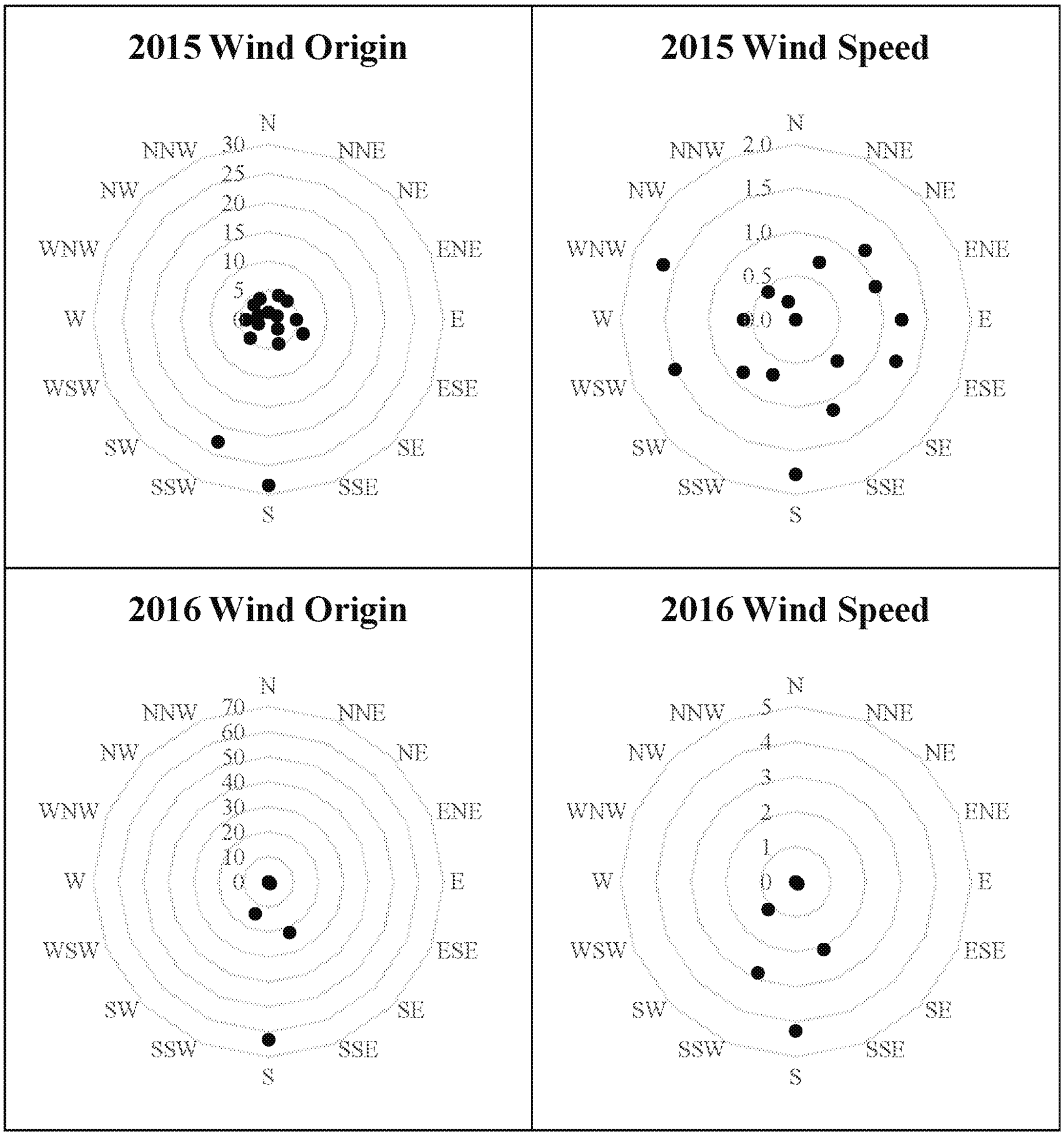

Figure 1. Web diagrams displaying wind speed and origin for 2 d after application in 2015 and 2016 at the Northeast Research and Extension Center in Keiser, AR. Wind origin is presented as percentage of all hourly measurements. Wind speed is presented as average wind speed (m s^{-1}) for each reported direction. Arrow originating from the center of each diagram indicates wind direction during application.

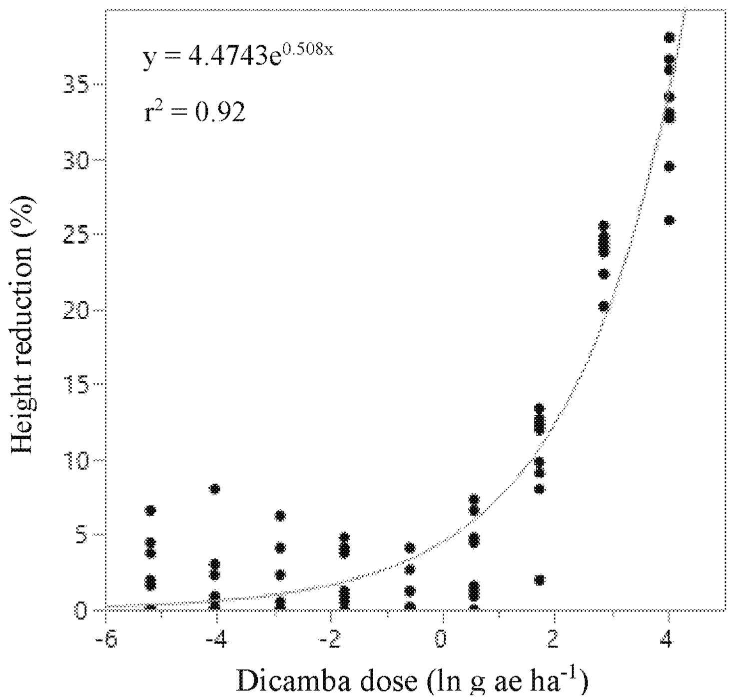

Figure 2. Two-parameter exponential growth model of the effect of dicamba dose on height reduction at 21 days after application to vegetative soybean in 2015 at Keiser, AR. Regression parameters are available in Table 16.

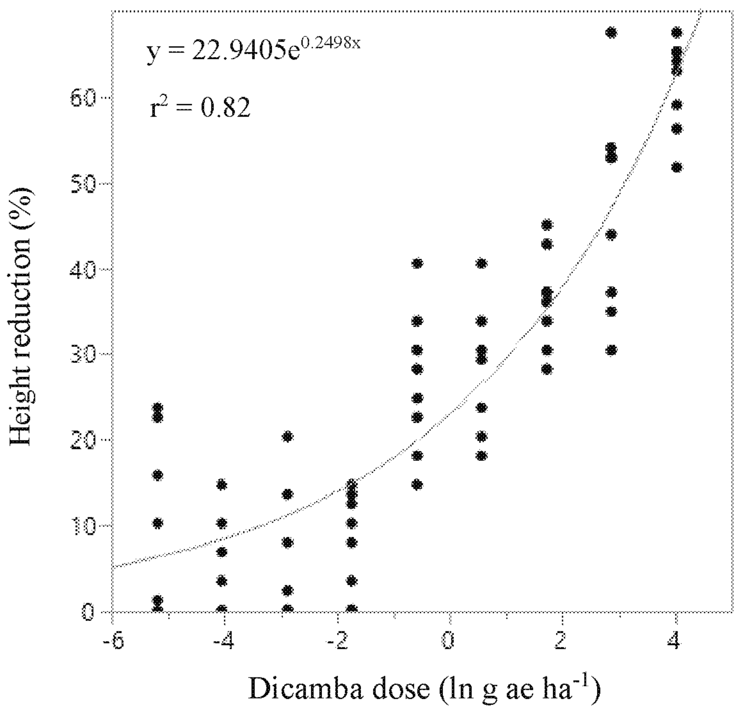

Figure 3. Two-parameter exponential growth model of the effect of dicamba dose (g ae ha-1) on height reduction at 21 days after application to vegetative soybean in 2016 at Keiser, AR. Regression parameters are available in Table 16.

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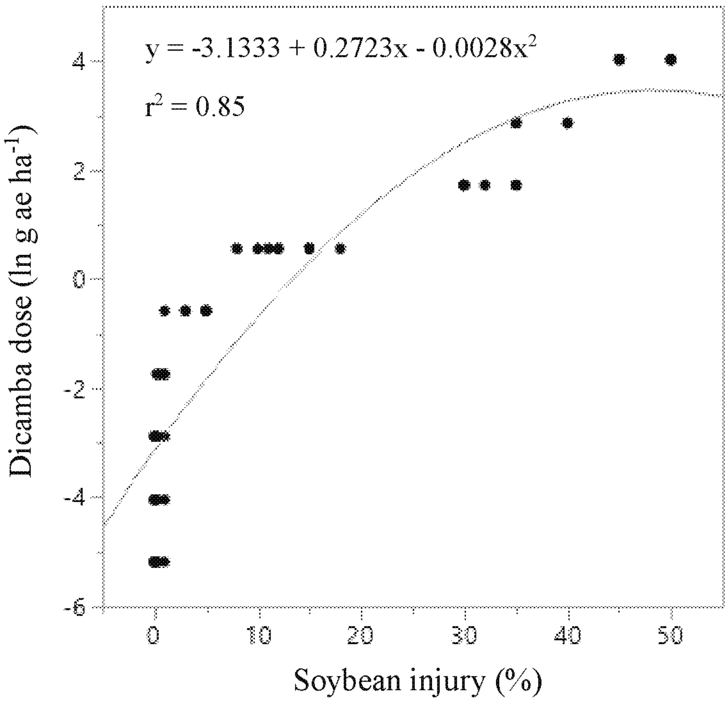


Figure 4. Quadratic model for predicting dicamba dose (g ae ha^{-1}) in the large drift experiments using soybean injury at 21 days after application in 2015 at Keiser, AR. Regression parameters are available in Table 17.

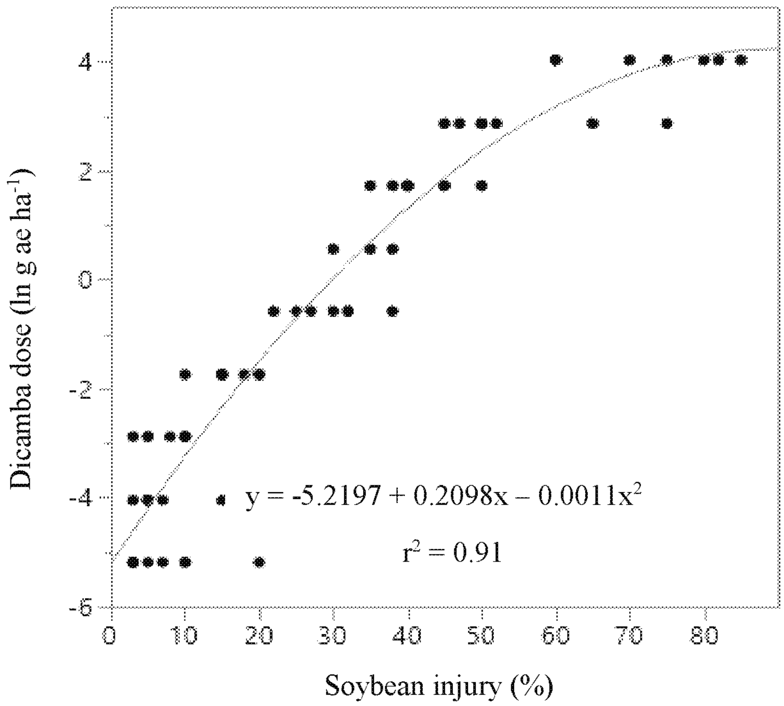


Figure 5. Quadratic model for predicting dicamba dose (g ae ha^{-1}) in the large drift experiments using soybean injury at 21 days after application in 2016 at Keiser, AR. Regression parameters are available in Table 17.

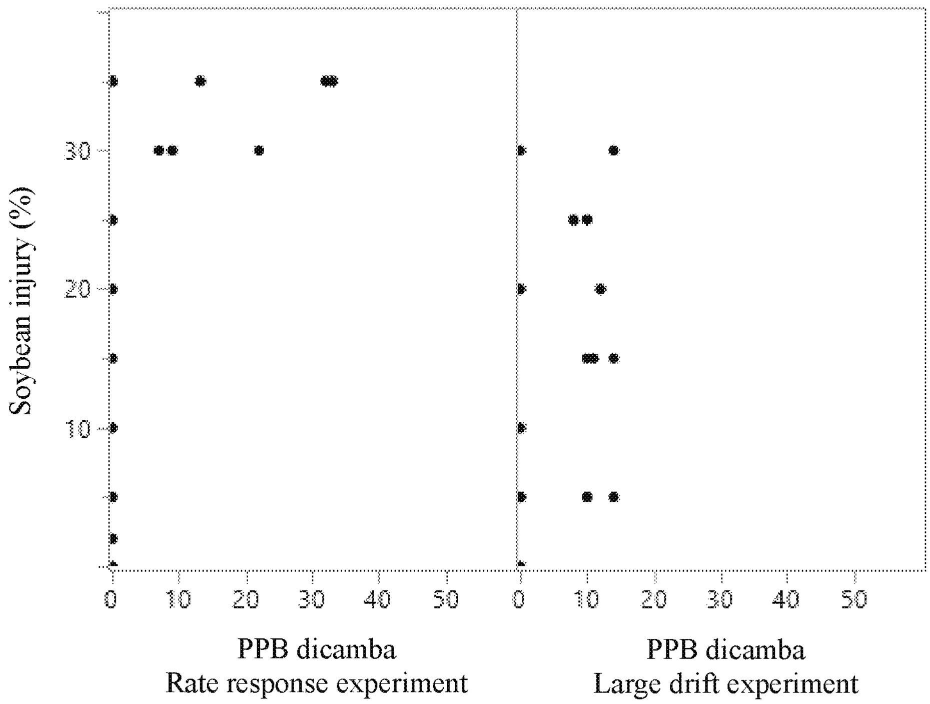


Figure 6. Scatterplot matrix of soybean injury and ppb (parts per billion) diglycolamine dicamba recovered in soybean tissue harvested at 7 days after application in 2015 at Keiser, AR. The dicamba detection limit was 1 ppb.

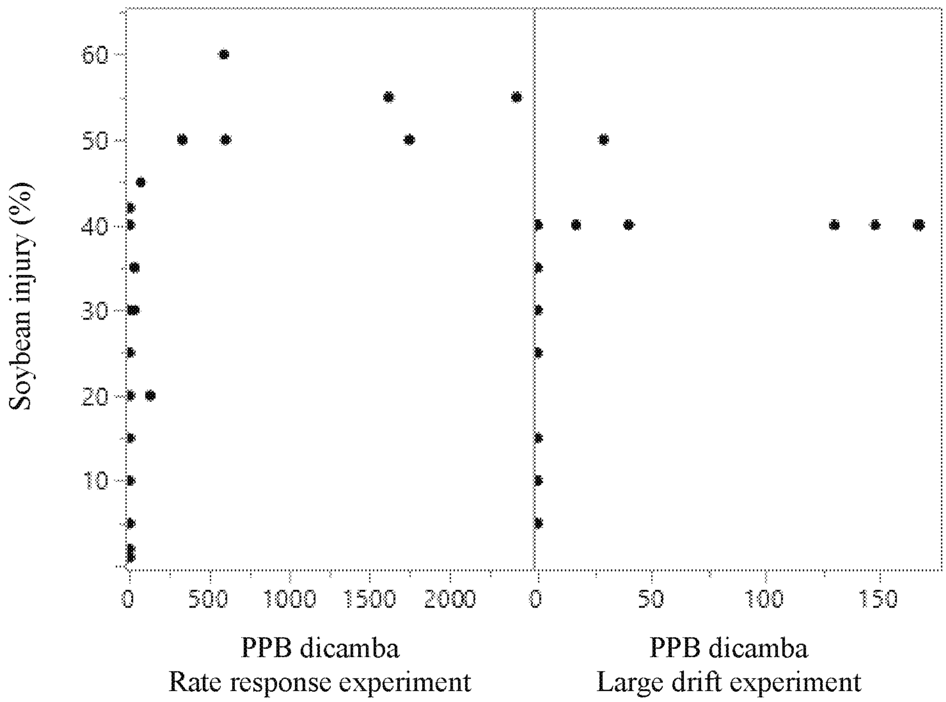


Figure 7. Scatterplot matrix of soybean injury and ppb (parts per billion) diglycolamine dicamba recovered in soybean tissue harvested at 7 days after application in 2016 at Keiser, AR. The dicamba detection limit was 1 ppb.

General Conclusions

Dicamba is highly useful in weed management programs as it will provide another postemergence site of action to control Palmer amaranth in areas where glufosinate-resistant soybean and cotton are a grower's only option. History shows that overreliance on a single herbicide may eventually lead to resistance. However, dicamba poses unique problems such as volatility and potential to damage highly susceptible crops such as non-DR soybean.

Yield reduction occurred to soybean at a distance nearly 3 times (90.4 m) that of the labeled setback (33.3 m) for endangered species at the field edge. Furthermore, soybean offspring could be at risk to negative affects when dicamba drift occurs at later reproductive stages. Soybean pod malformation when dicamba drift occurs at growth stage R5 was documented to be predictive of these negative offspring affects such as reduced emergence, reduced vigor, and injury.

Based on current label guidelines, the addition of a product to XtendiMax, FeXapan, or Engenia herbicides must be analyzed on a case-by-case basis with the sole purpose being the effect of the additive on droplet spectrum. Currently, many forms of glyphosate are labeled for mixing with these new dicamba products. Yet, in some cases, a drift reducing agent (DRA) must be used also to negate the effects that certain glyphosate formulations have on reducing droplet spectrum. However, this research demonstrates that there is another concern of such mixtures. Low-rate applications of dicamba and glyphosate were demonstrated to increase leaf malformation at R1 and increase pod malformation at R3 exposure, although negative effects on soybean offspring were not intensified by the addition of glyphosate. It is currently unclear just why increased injury occurs with low-rate exposure of the mixture, but it is hypothesized that glyphosate is aiding translocation of dicamba.

Engenia (BAPMA dicamba) was documented to have reduced secondary movement when compared to Clarity (DGA dicamba). However, secondary movement was still documented out to 108 m (1% injury) and is expected to increase in proportion to the area applied. This level of injury may be short-lived, and although not tested in these studies, it is expected that height and yield reduction will not occur at such low injury levels. However, 10 to 15% injury by secondary exposure was observed for both dicamba products at distances beyond the current buffer requirements. In addition, multiple exposures of dicamba could occur as growers will typically apply the herbicide twice with approximately two weeks between applications. Therefore, further research may be needed to evaluate the effect on height and yield of multiple dicamba exposures to non-DR soybean.

Proper stewardship of XtendiMax and Engenia herbicides will be key in their longevity. Label guidelines like those imposed on these two herbicides have not been seen previously. Proper nozzles, pressure, and boom height are vital in reducing primary drift of dicamba products. However, environmental conditions during and following application will contribute to the extent of secondary drift. While primary drift may be adequately controlled when using label guidelines, secondary movement may still occur if environmental conditions allow. In summary, these experiments demonstrate the danger that dicamba could pose on non-DR soybean as current guidelines will need to be stringently followed so that dicamba may be used to fight against problematic resistant weeds in DR soybean and cotton.

Appointment

From: Dallas Peterson [dpeterso@ksu.edu]
Sent: 1/16/2018 8:59:54 PM
To: Han, Kaythi [Han.Kaythi@epa.gov]; tdrake@clemson.edu; Becker, Jonathan [Becker.Jonathan@epa.gov]; 'Greg Kruger' [greg.kruger@unl.edu]; Mike Owen [mdowen@iastate.edu]; bscott@uaex.edu; Corbin, Mark [Corbin.Mark@epa.gov]; Dallas Peterson [dpeterso@oznet.ksu.edu]; Cory, Preston (Katherine) [Cory.Preston@epa.gov]; Rowland, Grant [Rowland.Grant@epa.gov]; Giguere, Cary (Cary.Giguere@vermont.gov) [Cary.Giguere@vermont.gov]; Berckes, Nicole [Berckes.Nicole@epa.gov]; ALFRED Culpepper [stanley@uga.edu]; eprostko@uga.edu; Aaron Hager [hager@illinois.edu]; Mark Loux [loux.1@osu.edu]; Green, Jamie [Green.Jamie@epa.gov]; Rosenblatt, Daniel [Rosenblatt.Dan@epa.gov]; Group Audio-Teleconf [Audio-Teleconf@epa.gov]; Mike Barrett [mbarrett@uky.edu]; Baris, Reuben [Baris.Reuben@epa.gov]; Beck, Nancy [Beck.Nancy@epa.gov]; Keigwin, Richard [Keigwin.Richard@epa.gov]; Meadows, Sarah [Meadows.Sarah@epa.gov]; Bond, Jason [JBond@drec.msstate.edu]; Paluch, Gretchen [Gretchen.Paluch@Iowaagriculture.gov]; bradleyke@missouri.edu; Wormell, Lance [Wormell.Lance@epa.gov]; Tom Barber [tbarber@uaex.edu]; Bennett, Tate [Bennett.Tate@epa.gov]; Amy Bamber [aapco.sfireg@gmail.com]; tmueller@utk.edu; Kenny, Daniel [Kenny.Dan@epa.gov]; DCRoomPYS7731E/Potomac-Yard-One [DCRoomPYS7731E@epa.gov]; Lott, Don [Lott.Don@epa.gov]; Ambrosino, Helene [Ambrosino.Helene@epa.gov]; Anderson, Meaghan J [EXTAG] [mjanders@iastate.edu]; Bill Johnson [wgj@purdue.edu]; Jakob, Avivah [Jakob.Avivah@epa.gov]; Chism, William [Chism.Bill@epa.gov]; Miller, Wynne [Miller.Wynne@epa.gov]; Pease, Anita [Pease.Anita@epa.gov]; Jason Norsworthy [jnorswor@uark.edu]; Schroeder, Jill [Jill.Schroeder@ARS.USDA.GOV]; Larry Steckel [lsteckel@utk.edu]; Trivedi, Adrienne [Trivedi.Adrienne@epa.gov]; Strauss, Linda [Strauss.Linda@epa.gov]; Montague, Kathryn V. [Montague.Kathryn@epa.gov]; Bob Hartzler [hartzler@iastate.edu]; jason.bond@msstate.edu; Sisco, Debby [Sisco.Debby@epa.gov]; Lee VanWychen [Lee.VanWychen@wssa.net]; bradleyke@misourri.edu; tony.cofer@agi.alabama.gov; Goodis, Michael [Goodis.Michael@epa.gov]

Subject: Canceled: Dicamba training
Location: Nemaha Co

Start: 2/7/2018 6:00:00 AM
End: 2/8/2018 6:00:00 AM
Show Time As: Free

Recurrence: (none)

Appointment

From: Dallas Peterson [dpeterso@ksu.edu]
Sent: 1/16/2018 8:59:54 PM
To: Dallas Peterson [dpeterso@ksu.edu]; Han, Kaythi [Han.Kaythi@epa.gov]; tdrake@clemson.edu; Becker, Jonathan [Becker.Jonathan@epa.gov]; 'Greg Kruger' [greg.kruger@unl.edu]; Mike Owen [mdowen@iastate.edu]; bscott@uaex.edu; Corbin, Mark [Corbin.Mark@epa.gov]; Dallas Peterson [dpeterso@oznet.ksu.edu]; Cory, Preston (Katherine) [Cory.Preston@epa.gov]; Rowland, Grant [Rowland.Grant@epa.gov]; Giguere, Cary (Cary.Giguere@vermont.gov) [Cary.Giguere@vermont.gov]; Berckes, Nicole [Berckes.Nicole@epa.gov]; ALFRED Culpepper [stanley@uga.edu]; eprostko@uga.edu; Aaron Hager [hager@illinois.edu]; Mark Loux [loux.1@osu.edu]; Green, Jamie [Green.Jamie@epa.gov]; Rosenblatt, Daniel [Rosenblatt.Dan@epa.gov]; Group Audio-Teleconf [Audio-Teleconf@epa.gov]; Mike Barrett [mbarrett@uky.edu]; Baris, Reuben [Baris.Reuben@epa.gov]; Beck, Nancy [Beck.Nancy@epa.gov]; Keigwin, Richard [Keigwin.Richard@epa.gov]; Meadows, Sarah [Meadows.Sarah@epa.gov]; Bond, Jason [JBond@drec.msstate.edu]; Paluch, Gretchen [Gretchen.Paluch@Iowaagriculture.gov]; bradleyke@missouri.edu; Wormell, Lance [Wormell.Lance@epa.gov]; Tom Barber [tbarber@uaex.edu]; Bennett, Tate [Bennett.Tate@epa.gov]; Amy Bamber [aapco.sfireg@gmail.com]; tmueller@utk.edu; Kenny, Daniel [Kenny.Dan@epa.gov]; DCRoomPYS7731E/Potomac-Yard-One [DCRoomPYS7731E@epa.gov]; Lott, Don [Lott.Don@epa.gov]; Ambrosino, Helene [Ambrosino.Helene@epa.gov]; Anderson, Meaghan J [EXTAG] [mjanders@iastate.edu]; Bill Johnson [wgj@purdue.edu]; Jakob, Avivah [Jakob.Avivah@epa.gov]; Chism, William [Chism.Bill@epa.gov]; Miller, Wynne [Miller.Wynne@epa.gov]; Pease, Anita [Pease.Anita@epa.gov]; Jason Norsworthy [jnorswor@uark.edu]; Schroeder, Jill [Jill.Schroeder@ARS.USDA.GOV]; Larry Steckel [lsteckel@utk.edu]; Trivedi, Adrienne [Trivedi.Adrienne@epa.gov]; Strauss, Linda [Strauss.Linda@epa.gov]; Montague, Kathryn V. [Montague.Kathryn@epa.gov]; Bob Hartzler [hartzler@iastate.edu]; jason.bond@msstate.edu; Sisco, Debby [Sisco.Debby@epa.gov]; Lee VanWychen [Lee.VanWychen@wssa.net]; bradleyke@misourri.edu; tony.cofer@agi.alabama.gov; Goodis, Michael [Goodis.Michael@epa.gov]

Subject: Canceled: Dicamba training
Location: Nemaha Co

Start: 2/7/2018 6:00:00 AM
End: 2/8/2018 6:00:00 AM
Show Time As: Free

Recurrence: (none)

Appointment

From: Hopkins, Yvette [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=8144c2f08de24390a9a3724cff13d95d-Yvette Hopkins]
Sent: 7/16/2018 4:12:18 PM
To: Hopkins, Yvette [Hopkins.Yvette@epa.gov]; Baris, Reuben [Baris.Reuben@epa.gov]; Montague, Kathryn V. [Montague.Kathryn@epa.gov]; Rowland, Grant [Rowland.Grant@epa.gov]; Meadows, Sarah [Meadows.Sarah@epa.gov]; bradleyke@misourri.edu; Bill Johnson [wgj@purdue.edu]; Aaron Hager [hager@illinois.edu]; Dallas Peterson [dpeterso@oznet.ksu.edu]; Tom Barber [tbarber@uaex.edu]; bscott@uaex.edu; jason.bond@msstate.edu; Larry Steckel [lsteckel@utk.edu]; Mark Loux [loux.1@osu.edu]; tmueller@utk.edu; Bob Hartzler [hartzler@iastate.edu]; Mike Owen [mdowen@iastate.edu]; ALFRED Culpepper [stanley@uga.edu]; eprostko@uga.edu; Ambrosino, Helene [Ambrosino.Helene@epa.gov]; Schroeder, Jill [Jill.Schroeder@ARS.USDA.GOV]; Lee VanWychen [Lee.VanWychen@wssa.net]; Jason Norsworthy [jnorswor@uark.edu]; Kenny, Daniel [Kenny.Dan@epa.gov]; 'Greg Kruger' [greg.kruger@unl.edu]; tony.cofer@agi.alabama.gov; Giguere, Cary (Cary.Giguere@vermont.gov) [Cary.Giguere@vermont.gov]; Amy Bamber [aapco.sfireg@gmail.com]; Paluch, Gretchen [Gretchen.Paluch@Iowaagriculture.gov]; tdrake@clemson.edu; Goodis, Michael [Goodis.Michael@epa.gov]; Keigwin, Richard [Keigwin.Richard@epa.gov]; Wormell, Lance [Wormell.Lance@epa.gov]; Rosenblatt, Daniel [Rosenblatt.Dan@epa.gov]; Lott, Don [Lott.Don@epa.gov]; Trivedi, Adrienne [Trivedi.Adrienne@epa.gov]; bradleyke@missouri.edu; Berckes, Nicole [Berckes.Nicole@epa.gov]; Sisco, Debby [Sisco.Debby@epa.gov]; Strauss, Linda [Strauss.Linda@epa.gov]; Miller, Wynne [Miller.Wynne@epa.gov]; Chism, William [Chism.Bill@epa.gov]
CC: Barrett, Michael [mbarrett@uky.edu]; Green, Jamie [Green.Jamie@epa.gov]; Bond, Jason [JBond@drec.msstate.edu]; Beck, Nancy [Beck.Nancy@epa.gov]; Bennett, Tate [Bennett.Tate@epa.gov]; Jakob, Avivah [Jakob.Avivah@epa.gov]; Dallas Peterson [dpeterso@ksu.edu]; Han, Kaythi [Han.Kaythi@epa.gov]; Corbin, Mark [Corbin.Mark@epa.gov]; Becker, Jonathan [Becker.Jonathan@epa.gov]; Pease, Anita [Pease.Anita@epa.gov]; Cory, Preston (Katherine) [Cory.Preston@epa.gov]; Anderson, Meaghan J [EXTAG] [mjanders@iastate.edu]; Audio-Teleconf [Audio-Teleconf@epa.gov]

Subject: Dicamba Discussion with Extension and State Lead Agencies via EOP / Ex. 6 (code EOP / Ex. 6 Agenda attached and appended below- Now includes a new pfd from K. Bradley
Location: DCRoomPYS7731E/Potomac-Yard-One

Start: 7/28/2017 2:00:00 PM
End: 7/28/2017 4:00:00 PM
Show Time As: Busy

Recurrence: (none)

<u>Background</u>

Since June 2017, the EPA has been receiving reports regarding a high number of crop damage incidents involving the active ingredient dicamba. The number of complaints is especially high in Arkansas, Illinois, Missouri, Mississippi, and Tennessee. Recently, a number of other states are reporting complaints including more northern states.

New formulations of dicamba were registered by the Agency for use on dicamba-tolerant cotton and soybeans late in 2016 (Monsanto's DGA in November and BASFs BAPMA in December). EPA appreciates the opportunity to discuss these cases of crop damage more fully and better understand the underlying science and leading factors contributing to the crop damage.

Dicamba: Discussion with State Extension Representatives
July 28, 2017

<u>Agenda</u>

I. Meeting Introductions OPP & USDA

II. Meeting Format (RD) Kenny/Baris

III. Mapping of incidents/damage overview (Bradley)

IV. Extension's Input on Dicamba Incidents (30-40 min) *EPA is soliciting feedback from extension agents focusing on information that could help remedy the unacceptable dicamba incidents in the field. We would like to hear from each of the extension experts with their insights related especially to the following:*

1. Based on information available to you, so far, what would you describe as the leading causes of crop damage incidents in your state?
2. What are you seeing out in the field that led you to that conclusion? Are you working on any additional data that is relevant to the issues? Are you able to share any of this information with the EPA?
3. Based on the leading causes, what approaches would you recommend to fix the problem?

Arkansas (Norsworthy, Barber, and Scott)
Georgia (Culpepper and Prostko)
Illinois (Hager)
Indiana (Johnson and Young)
Iowa (Hartzler and Owen)
Kansas (Peterson)
Kentucky (Barrett)
Mississippi (Bond)
Missouri (Bradley)
Ohio (Loux)
Tennessee (Steckel and Mueller)

V. Volatility Data/Discussion (Bradley) (20-30 min)

VI. Additional Discussion and Questions (time permitting)

VII. Closing Remarks/next steps

Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 4/12/2018 4:09:08 PM
To: Chism, William [Chism.Bill@epa.gov]
CC: Bagavathiannan, Muthukumar V [muthu@tamu.edu]
Subject: Re: I would like to use your map of Palmer amaranth spread but I don't know how to cite it.

Hi Bill,

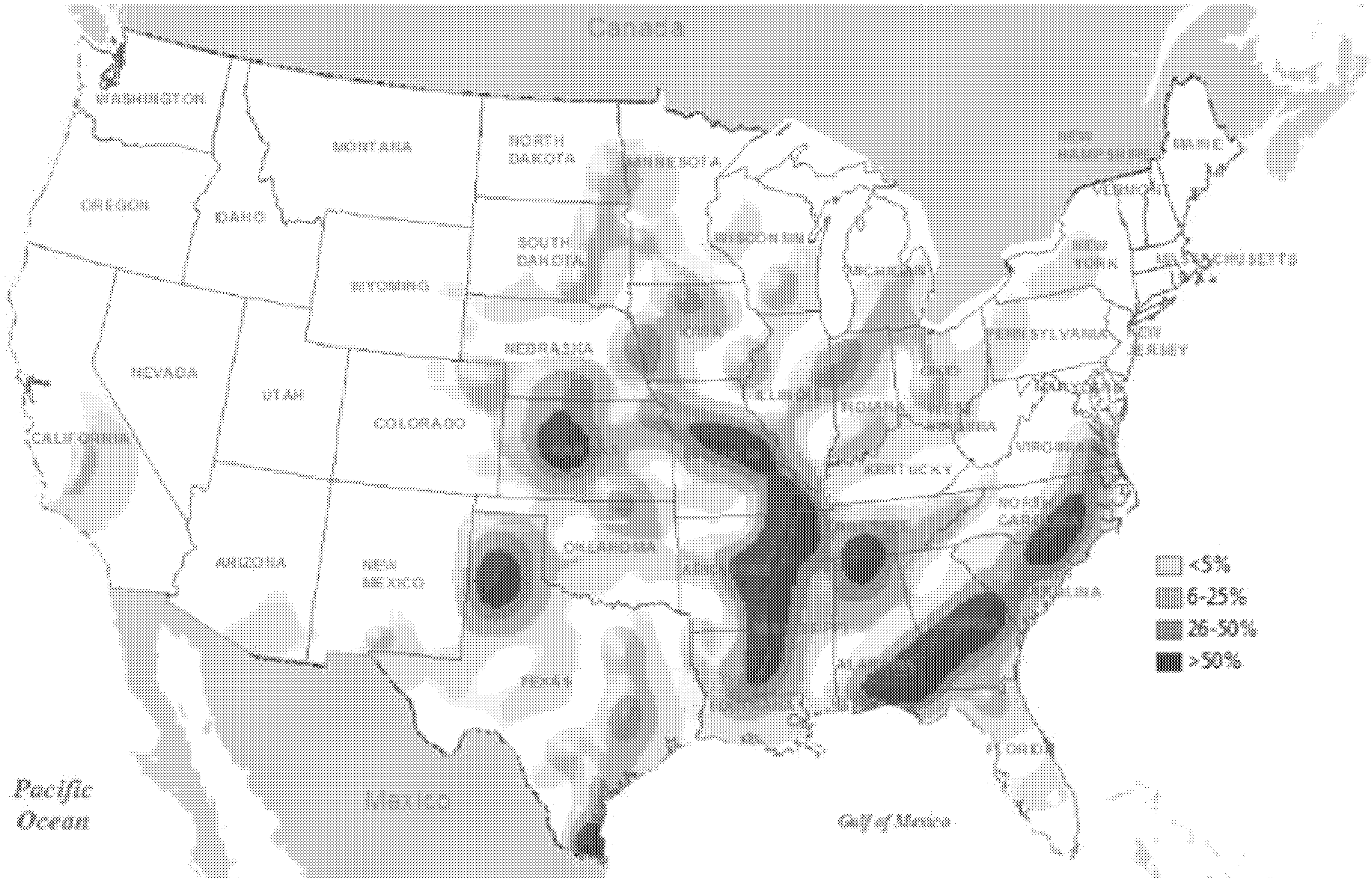
I believe the way you currently have it presented is appropriate.

Regards,
Jason

Sent from my iPhone

On Apr 12, 2018, at 10:54 AM, Chism, William <Chism.Bill@epa.gov> wrote:

> Hi Jason and Muthu
> In early May we will be talking to the Pesticide Program Dialogue Committee (PPDC) about our herbicide resistance communication plan. I found your map on the internet and think it would be helpful in our discussion but I don't know how to reference the source. Is it okay to use the map and how shall I reference the source?
> Thank you. Bill
> <image002.jpg>
> Source: M. Bagavathiannan and J. Norsworthy
>
> ----------------------------------
> Bill Chism, Ph.D.
> Senior Biologist
> Biological and Economic Analysis Division
> U.S. EPA/Office of Pesticide Programs
> (703) 308-8136
> chism.bill@epa.gov



PALMER AMARANTH SPREAD - WORST-CASE BY 2020

Message

From: Chism, William [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=475879B16C29401A9449DDB69D5F7EB1-WILLIAM CHISM]
Sent: 4/12/2018 4:17:15 PM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
CC: Bagavathiannan, Muthukumar V [muthu@tamu.edu]
Subject: RE: I would like to use your map of Palmer amaranth spread but I don't know how to cite it.

Hi Jason
Thank you.
Bill

Bill Chism
Senior Biologist
Biological and Economic Analysis Division
U.S. EPA/Office of Pesticide Programs
(703) 308-8136
chism.bill@epa.gov

From: Jason Keith Norsworthy [mailto:jnorswor@uark.edu]
Sent: Thursday, April 12, 2018 12:09 PM
To: Chism, William <Chism.Bill@epa.gov>
Cc: Bagavathiannan, Muthukumar V <muthu@tamu.edu>
Subject: Re: I would like to use your map of Palmer amaranth spread but I don't know how to cite it.

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Thank you. Bill

<image002.jpg>

Source: M. Bagavathiannan and J. Norsworthy

Bill Chism, Ph.D.
Senior Biologist
Biological and Economic Analysis Division
U.S. EPA/Office of Pesticide Programs
(703) 308-8136

chism.bill@epa.gov

Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 10/5/2018 8:59:38 PM
To: Corbin, Mark [Corbin.Mark@epa.gov]
Subject: RE: Phone Call
Attachments: one pager update norsworthy 100518 (JKN).docx

Hi Mark,

Attached is the document with a few minor edits incorporated.

Hope you have great weekend.

Regards,
Jason

Jason Norsworthy, PhD
Professor and Elms Farming Chair of Weed Science
1366 West Altheimer Dr.
Fayetteville, AR 72704
Tel: 479-575-8740
Mob: 479-313-1265

From: Corbin, Mark <Corbin.Mark@epa.gov>
Sent: Friday, October 5, 2018 12:31 PM
To: Jason Keith Norsworthy <jnorswor@uark.edu>
Cc: Odenkirchen, Edward <Odenkirchen.Edward@epa.gov>; Anderson, Brian <Anderson.Brian@epa.gov>; Peck, Charles <Peck.Charles@epa.gov>; Farruggia, Frank <Farruggia.Frank@epa.gov>
Subject: Phone Call

Dr Norsworthy

Thank you for taking the time out yesterday to walk us through your data and answer all of the questions we need to address. To that end we have drafted a one-pager for our management to summarize the points we discussed and the responses. We would like to run that by you to ensure that it accurately reflects your take on what we discussed and the points that were made.

I realize you are busy but if you have time please take a look at the attached summary and provide and any feedback you can it would be much appreciated. And of course if you have any questions please let me know. We are off Monday for Columbus day but I will be around Tuesday.

Thank you again

Mark Corbin
Branch Chief, Environmental Risk Branch 6
Environmental Fate and Effects Division (7507P)
Office of Pesticide Programs
U.S. Environmental Protection Agency

Washington DC 20460
703-605-0033

Message

From: Corbin, Mark [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=1DB182663B134E46B3FEC580F8E0B5F2-MARK CORBIN]
Sent: 10/5/2018 5:31:04 PM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
CC: Odenkirchen, Edward [Odenkirchen.Edward@epa.gov]; Anderson, Brian (Anderson.Brian@epa.gov) [Anderson.Brian@epa.gov]; Peck, Charles [Peck.Charles@epa.gov]; Farruggia, Frank [Farruggia.Frank@epa.gov]
Subject: Phone Call
Attachments: one pager update norsworthy 100518.docx

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Thank you again

Mark Corbin
Branch Chief, Environmental Risk Branch 6
Environmental Fate and Effects Division (7507P)
Office of Pesticide Programs
U.S. Environmental Protection Agency
Washington DC 20460
703-605-0033

Message

From: Corbin, Mark [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=1DB182663B134E46B3FEC580F8E0B5F2-MARK CORBIN]
Sent: 10/3/2018 12:51:21 PM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
Subject: RE: field trial questions

How about 11 am EST tomorrow (is that 10 am your time?)?

If good what number should we call you on?

mark

From: Jason Keith Norsworthy [mailto:jnorswor@uark.edu]
Sent: Wednesday, October 03, 2018 8:32 AM
To: Corbin, Mark <Corbin.Mark@epa.gov>
Subject: RE: field trial questions

I am available any time tomorrow, but am out of the office today. Let me know what time works for you.

Regards,
Jason

Jason Norsworthy, PhD
Professor and Elms Farming Chair of Weed Science
1366 West Altheimer Dr.
Fayetteville, AR 72704
Tel: 479-575-8740
Mob: 479-313-1265

From: Corbin, Mark <Corbin.Mark@epa.gov>
Sent: Wednesday, October 3, 2018 7:28 AM
To: Jason Keith Norsworthy <jnorswor@uark.edu>
Cc: Baris, Reuben <Baris.Reuben@epa.gov>
Subject: field trial questions

Dr Norsworthy

Our team here in EFED have been looking over the data and slides you sent us and we have a few questions we would like to go over with you today if possible. It would be the usual folks here (Chuck Peck, Ed Odenkirchen, Reuben, myself) and just internal to OPP.

Would you be available today at either 1 to 2, or from 2 to 3 EST? If that doesn't work for you is there a time that is best? We will call you.

Thank you

Mark Corbin
Branch Chief, Environmental Risk Branch 6
Environmental Fate and Effects Division (7507P)
Office of Pesticide Programs
U.S. Environmental Protection Agency
Washington DC 20460
703-605-0033

Message

From: Peck, Charles [Peck.Charles@epa.gov]
Sent: 10/10/2018 3:01:31 PM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
CC: Corbin, Mark [Corbin.Mark@epa.gov]; Odenkirchen, Edward [Odenkirchen.Edward@epa.gov]; Connolly, Jennifer [Connolly.Jennifer@epa.gov]
Subject: RE: Follow-up Question on 2017 Data

Awesome! That's what Reuben thought too, but just wanted to confirm – thanks!

Chuck Peck
OPP/EFED/ERB VI
Potomac Yard South
Crystal City, VA
Room 10244
(703) 347-8064
peck.charles@epa.gov

From: Jason Keith Norsworthy [mailto:jnorswor@uark.edu]
Sent: Wednesday, October 10, 2018 11:00 AM
To: Peck, Charles <Peck.Charles@epa.gov>
Cc: Corbin, Mark <Corbin.Mark@epa.gov>; Odenkirchen, Edward <Odenkirchen.Edward@epa.gov>; Connolly, Jennifer <Connolly.Jennifer@epa.gov>
Subject: Re: Follow-up Question on 2017 Data

I believe Columbia, MO

Sent from my iPhone

On Oct 10, 2018, at 9:58 AM, Peck, Charles <Peck.Charles@epa.gov> wrote:

> Hi Jason,
>
> Quick question on the 2017 data you sent – do you know what city Dr. Bradley conducted the MO study in? Thanks!
>
> Chuck Peck
> OPP/EFED/ERB VI
> Potomac Yard South
> Crystal City, VA
> Room 10244
> (703) 347-8064
> peck.charles@epa.gov

Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 10/10/2018 2:59:45 PM
To: Peck, Charles [Peck.Charles@epa.gov]
CC: Corbin, Mark [Corbin.Mark@epa.gov]; Odenkirchen, Edward [Odenkirchen.Edward@epa.gov]; Connolly, Jennifer [Connolly.Jennifer@epa.gov]
Subject: Re: Follow-up Question on 2017 Data

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> Chuck Peck
> OPP/EFED/ERB VI
> Potomac Yard South
> Crystal City, VA
> Room 10244
> (703) 347-8064
> peck.charles@epa.gov

Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 10/9/2018 6:05:56 PM
To: Corbin, Mark [Corbin.Mark@epa.gov]
Subject: Re: Phone Call

Applications were made July 20, 2015 and July 6, 2016.

Sent from my iPhone

On Oct 9, 2018, at 10:24 AM, Corbin, Mark <Corbin.Mark@epa.gov> wrote:

> Thanks again for the clarifications
>
> Quick follow up question. Do you know from Chapter 4 from the Jones thesis what date applications occurred?
>
> We can't find them in the thesis
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> Mark
>
> Sent from my iPhone
>
> On Oct 5, 2018, at 4:59 PM, Jason Keith Norsworthy <jnorswor@uark.edu> wrote:
>
>> Hi Mark,
>>
>> Attached is the document with a few minor edits incorporated.
>>
>> Hope you have great weekend.
>>
>> Regards,
>> Jason
>>
>> Jason Norsworthy, PhD
>> Professor and Elms Farming Chair of Weed Science
>> 1366 West Altheimer Dr.
>> Fayetteville, AR 72704
>> Tel: 479-575-8740
>> Mob: 479-313-1265
>>
>> ---
>>
>> **From:** Corbin, Mark <Corbin.Mark@epa.gov>
>> **Sent:** Friday, October 5, 2018 12:31 PM
>> **To:** Jason Keith Norsworthy <jnorswor@uark.edu>
>> **Cc:** Odenkirchen, Edward <Odenkirchen.Edward@epa.gov>; Anderson, Brian <Anderson.Brian@epa.gov>; Peck, Charles <Peck.Charles@epa.gov>; Farruggia, Frank <Farruggia.Frank@epa.gov>
>> **Subject:** Phone Call

Dr Norsworthy

Thank you for taking the time out yesterday to walk us through your data and answer all of the questions we need to address. To that end we have drafted a one-pager for our management to summarize the points we discussed and the responses. We would like to run that by you to ensure that it accurately reflects your take on what we discussed and the points that were made.

I realize you are busy but if you have time please take a look at the attached summary and provide and any feedback you can it would be much appreciated. And of course if you have any questions please let me know. We are off Monday for Columbus day but I will be around Tuesday.

Thank you again

Mark Corbin
Branch Chief, Environmental Risk Branch 6
Environmental Fate and Effects Division (7507P)
Office of Pesticide Programs
U.S. Environmental Protection Agency
Washington DC 20460
703-605-0033

<one pager update norsworthy 100518 (JKN).docx>

Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 10/3/2018 1:04:20 PM
To: Corbin, Mark [Corbin.Mark@epa.gov]
Subject: Re: field trial questions

Works for me. Call me at 479-313-1265. That will be 10:00 AM my time.

Sent from my iPhone

On Oct 3, 2018, at 7:51 AM, Corbin, Mark <Corbin.Mark@epa.gov> wrote:

> How about 11 am EST tomorrow (is that 10 am your time?)?
>
> If good what number should we call you on?
>
> mark
>
> **From:** Jason Keith Norsworthy [mailto:jnorswor@uark.edu]
> **Sent:** Wednesday, October 03, 2018 8:32 AM
> **To:** Corbin, Mark <Corbin.Mark@epa.gov>
> **Subject:** RE: field trial questions
>
> I am available any time tomorrow, but am out of the office today. Let me know what time works for you.
>
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> Jason
>
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> Professor and Elms Farming Chair of Weed Science
> 1366 West Altheimer Dr.
> Fayetteville, AR 72704
> Tel: 479-575-8740
> Mob: 479-313-1265
>
> **From:** Corbin, Mark <Corbin.Mark@epa.gov>
> **Sent:** Wednesday, October 3, 2018 7:28 AM
> **To:** Jason Keith Norsworthy <jnorswor@uark.edu>
> **Cc:** Baris, Reuben <Baris.Reuben@epa.gov>
> **Subject:** field trial questions
>
> Dr Norsworthy
>
> Our team here in EFED have been looking over the data and slides you sent us and we have a few questions we would like to go over with you today if possible. It would be the usual folks here (Chuck Peck, Ed Odenkirchen, Reuben, myself) and just internal to OPP.

Would you be available today at either 1 to 2, or from 2 to 3 EST? If that doesn't work for you is there a time that is best? We will call you.

Thank you

Mark Corbin
Branch Chief, Environmental Risk Branch 6
Environmental Fate and Effects Division (7507P)
Office of Pesticide Programs
U.S. Environmental Protection Agency
Washington DC 20460
703-605-0033

Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 10/3/2018 12:32:13 PM
To: Corbin, Mark [Corbin.Mark@epa.gov]
Subject: RE: field trial questions

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Jason Norsworthy, PhD
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1366 West Altheimer Dr.
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Mob: 479-313-1265

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Mark Corbin
Branch Chief, Environmental Risk Branch 6
Environmental Fate and Effects Division (7507P)
Office of Pesticide Programs
U.S. Environmental Protection Agency
Washington DC 20460
703-605-0033

Message

From: Corbin, Mark [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=1DB182663B134E46B3FEC580F8E0B5F2-MARK CORBIN]
Sent: 10/9/2018 6:06:50 PM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
Subject: RE: Phone Call

Thank you again

From: Jason Keith Norsworthy [mailto:jnorswor@uark.edu]
Sent: Tuesday, October 09, 2018 2:06 PM
To: Corbin, Mark <Corbin.Mark@epa.gov>
Subject: Re: Phone Call

Applications were made July 20, 2015 and July 6, 2016.

Sent from my iPhone

On Oct 9, 2018, at 10:24 AM, Corbin, Mark <Corbin.Mark@epa.gov> wrote:

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>
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>> Mob: 479-313-1265

From: Corbin, Mark <Corbin.Mark@epa.gov>
Sent: Friday, October 5, 2018 12:31 PM
To: Jason Keith Norsworthy <jnorswor@uark.edu>
Cc: Odenkirchen, Edward <Odenkirchen.Edward@epa.gov>; Anderson, Brian <Anderson.Brian@epa.gov>; Peck, Charles <Peck.Charles@epa.gov>; Farruggia, Frank <Farruggia.Frank@epa.gov>
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Environmental Fate and Effects Division (7507P)
Office of Pesticide Programs
U.S. Environmental Protection Agency
Washington DC 20460
703-605-0033

<one pager update norsworthy 100518 (JKN).docx>

Message

From: Corbin, Mark [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=1DB182663B134E46B3FEC580F8E0B5F2-MARK CORBIN]
Sent: 10/9/2018 3:24:29 PM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
Subject: Re: Phone Call

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Mark

Sent from my iPhone

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Environmental Fate and Effects Division (7507P)
Office of Pesticide Programs
U.S. Environmental Protection Agency
Washington DC 20460
703-605-0033

<one pager update norsworthy 100518 (JKN).docx>

Appointment

From: ONeill, Sandra [ONeill.Sandra@epa.gov]
Sent: 8/13/2018 1:06:15 PM
To: ONeill, Sandra [ONeill.Sandra@epa.gov]; Kaul, Monisha [Kaul.Monisha@epa.gov]; Chism, William [Chism.Bill@epa.gov]; Becker, Jonathan [Becker.Jonathan@epa.gov]; Biscoe, Melanie [Biscoe.Melanie@epa.gov]; Britton, Cathryn [Britton.Cathryn@epa.gov]; Basu, Bilin [Basu.Bilin@epa.gov]; jnorswor@uark.edu; hartzler@iastate.edu; jason.bond@msstate.edu; loux.1@osu.edu; gunso001@umn.edu; Thomas.J.Peters@ndsu.edu; sharon.clay@sdstate.edu; dpeterso@ksu.edu; todd.baughman@okstate.edu; DStephenson@agcenter.lsu.edu; scott.nolte@tamu.edu; GA [xzl0004@auburn.edu]; stanley@uga.edu; marsha3@clemson.edu; lsteckel@tennessee.edu; hager@illinois.edu; mjv@udel.edu; wgj@purdue.edu; IN, Joe Ikely [jikley@purdue.edu]; WI, Rodrigo Werle [rwerle@wisc.edu]; NE, Amit Jhala [amit.jhala@unl.edu]; MI, Christie Sprague [sprague1@msu.edu]; KT, JD Green [jdgreen@uky.edu]; TX, Peter Dotray [p-dotray@tamu.edu]; VA, Michael Flessner [flessner@vt.edu]; PA, Dwight Lingenfelter [dxl18@psu.edu]; AK, Tom Barber [tbarber@uaex.edu]; Meadows, Sarah [Meadows.Sarah@epa.gov]; Baris, Reuben [Baris.Reuben@epa.gov]; Kenny, Daniel [Kenny.Dan@epa.gov]; Schmid, Emily [Schmid.Emily@epa.gov]; Hathaway, Margaret [Hathaway.Margaret@epa.gov]; OPP FEAD GISB [OPP_FEAD_GISB@epa.gov]
CC: Wire, Cindy [Wire.Cindy@epa.gov]; Keller, Kaitlin [keller.kaitlin@epa.gov]; Wormell, Lance [Wormell.Lance@epa.gov]; Emdur, Zoe [Emdur.Zoe@epa.gov]; Ryan, Emily [ryan.emily@epa.gov]; Legleiter, Travis [Travis.Legleiter@uky.edu]; Green, Jonathan [jonathan.green@uky.edu]

Subject: FW: Extension Agent/Weed Scientist Dicamba Discussion with EPA: call in: EOP / Ex. 6 ID # EOP / Ex. 6
Location: DCRoomPYS7100/Potomac-Yard-One

Start: 8/13/2018 2:00:00 PM
End: 8/13/2018 3:00:00 PM
Show Time As: Busy

-----Original Appointment-----
From: ONeill, Sandra
Sent: Tuesday, August 07, 2018 4:49 PM
To: ONeill, Sandra; jnorswor@uark.edu; hartzler@iastate.edu; jason.bond@msstate.edu; loux.1@osu.edu; gunso001@umn.edu; Thomas.J.Peters@ndsu.edu; sharon.clay@sdstate.edu; dpeterso@ksu.edu; todd.baughman@okstate.edu; DStephenson@agcenter.lsu.edu; scott.nolte@tamu.edu; GA; stanley@uga.edu; marsha3@clemson.edu; lsteckel@tennessee.edu; hager@illinois.edu; mjv@udel.edu; wgj@purdue.edu; IN, Joe Ikely; WI, Rodrigo Werle; NE, Amit Jhala; MI, Christie Sprague; KT, JD Green; TX, Peter Dotray; VA, Michael Flessner; PA, Dwight Lingenfelter; AK, Tom Barber; Meadows, Sarah; Baris, Reuben; Kenny, Daniel; Schmid, Emily; Hathaway, Margaret; OPP FEAD GISB
Cc: Wire, Cindy; Keller, Kaitlin; Wormell, Lance; Emdur, Zoe; Ryan, Emily; Legleiter, Travis; Green, Jonathan
Subject: Extension Agent/Weed Scientist Dicamba Discussion with EPA: call in: EOP / Ex. 6 ID # EOP / Ex. 6
When: Monday, August 13, 2018 10:00 AM-11:00 AM (UTC-05:00) Eastern Time (US & Canada).
Where: DCRoomPYS7100/Potomac-Yard-One

Conference Number: EOP / Ex. 6
Conference ID: EOP / Ex. 6

All,

The purpose of this meeting is to share existing dicamba information. Given the short notice, if your state is not able to make the call time, we are happy to discuss outside of the call.

Agenda:

I. Introductions

II. Extension agent/weed scientist summary of current dicamba situation.

III. Extension agent/weed scientist suggestions for label updates, if OTT dicamba registrations were to be extended beyond this year.

Thank you,

Sandra O'Neill
Government Liaison
Government and International Services Branch II Field and External Affairs Division II OPP/OCSPP II U.S. EPA II (703) 347-0141

Message

From: Scott Senseman (via Google Docs) [ssensema@gmail.com]
Sent: 5/30/2018 8:43:37 PM
To: Keigwin, Richard [Keigwin.Richard@epa.gov]
CC: Sid Abel [Sidney.W.Abel@aphis.usda.gov]; chad.asmus@basf.com; marathonag@zianet.com; Baris, Reuben [Baris.Reuben@epa.gov]; Bradleyke@missouri.edu; jbunting@growmark.com; arlene.cotie@bayer.com; stanley@uga.edu; jferrell@ufl.edu; rgrant@purdue.edu; hager@illinois.edu; a.hewitt@uq.edu.au; Kenny, Daniel [Kenny.Dan@epa.gov]; gkruger2@unl.edu; rleon@ncsu.edu; BNichols@cottoninc.com; jnorswor@uark.edu; jeanp@ifca.com; jreiss@precisionlab.com; dreynolds@pss.msstate.edu; ssensema@utk.edu; DShaw@research.msstate.edu; wgs@turbodrop.com; ssmith@redgold.com; lsteckel@utk.edu; hthistle@fs.fed.us; Lee.VanWychen@wssa.net; Jweirich@mfa-inc.com; Peck, Charles [Peck.Charles@epa.gov]
Subject: Dicamba Report_May 30.docx - Invitation to edit

Scott Senseman has invited you to **edit** the following document:

Dicamba Report_May 30.docx

Dear Invitees and Participants,

Once again, I would like to thank all of you for being willing to participate in our April workshop in DC to discuss herbicide off-target movement. I believe that it was a very productive meeting and we hope to have a set of positive outcomes going forward. Our writing committee has done a great deal of work to capture the points made at the meeting and to provide a comprehensive report for your review. We very much would like to keep the review process short and to get feedback from this group in the next 7 days (by June 6, 2018 Close of Business). Upon that deadline, we will be sending it to two WSSA Committees, 1) Formulations, Adjuvants, and Application Technology and 2) Environmental Aspects for their input in the same timeframe. Finally, we will send the edited version to the registrants and ultimately to our webpage for display over the next several weeks.

I am planning to use Google Docs to facilitate the review process. The document can be accessed at this link. We have also created a link to all of the PDF files of the 11 presentations that were made at the Workshop. Any comments that you would like to provide will show up as suggested edits or you can add comments through the "insert" menu. If you have any issues seeing the document, please let me know and I will try another method.

Thank you again for helping us understand the data gaps related to this technology. We will do our best to use this information to the betterment of our producers and scientific discipline.

Sincerely,

Scott SensemanPresident, Weed Science Society of America

Scott A. Senseman
Professor and Department Head
Department of Plant Sciences
2431 Joe Johnson Drive, 252 Ellington Plant Sciences Building
Knoxville, Tennessee 37996

865-974-8033 Office / 865-974-1947 Fax
scottsenseman@tennessee.edu | https://ag.tennessee.edu/plantsciences

Follow on Twitter - @UTPSDeptHead
Follow Plant Sciences on Twitter - @utkplsc

Like Plant Sciences on Facebook - utkplsc
Keep in touch with alumni! Add Plant Sciences to your LinkedIN Profile https://lnkd.in/dANBcuz
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Google LLC, 1600 Amphitheatre Parkway, Mountain View, CA 94043, USA

You have received this email because someone shared a document with you from Google Docs.

Message

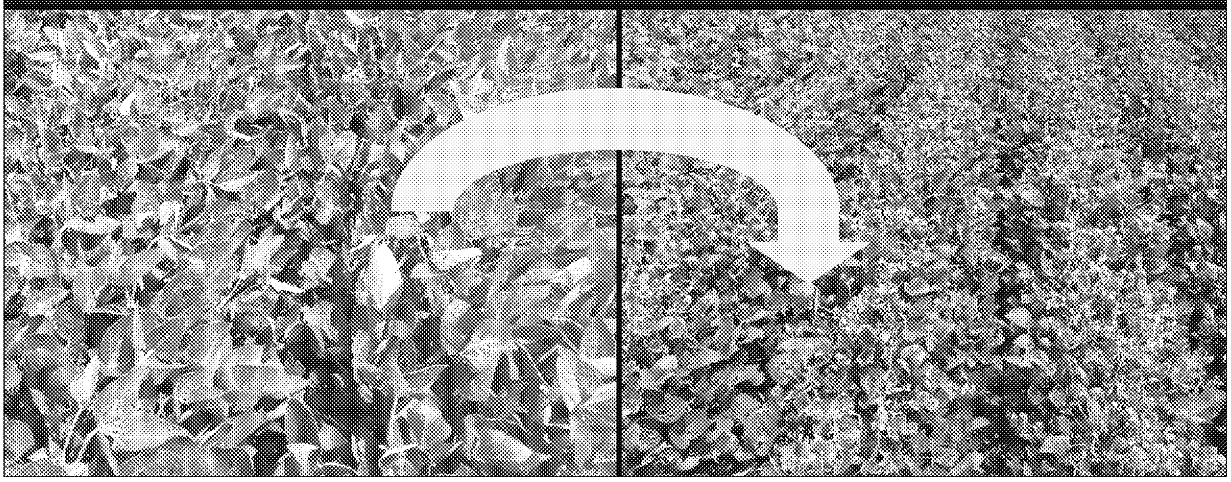
From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 3/20/2018 2:21:41 PM
To: Kenny, Daniel [Kenny.Dan@epa.gov]
Subject: WSSA presentation
Attachments: Norsworthy_WSSA_Dicamba_Presentation.ppt

Here is the presentation. Let me know if you have questions.

Jason Norsworthy, PhD
Professor and Elms Farming Chair of Weed Science
1366 West Altheimer Dr.
Fayetteville, AR 72704
Tel: 479-575-8740
Mob: 479-313-1265

Secondary Movement of XtendiMax and Engenia in Drift Trials: Is this Volatility?

J.K. Norsworthy, G. Kruger, D. Reynolds, L. Steckel, K. Bradley, B. Young



ACCEPTED
11/09/2016
Under the Federal Insecticide, Fungicide and Rodenticide Act as amended, for the pesticide registered under
EPA Reg. No. 524-617

SUPPLEMENTAL LABELING

READ THE ENTIRE LABEL FOR XTENDIMAX™ WITH VAPORGRIP™ TECHNOLOGY BEFORE PROCEEDING WITH THE USE DIRECTIONS CONTAINED IN THIS SUPPLEMENTAL LABELING.

When using XtendiMax™ With VaporGrip™ Technology as permitted according to this supplemental labeling, read and follow all applicable directions, restrictions, and precautions on the container label and booklet provided with the product container and on this supplemental labeling. This supplemental labeling must be in the possession of the user at the time of pesticide application.

Label expires on 11/09/2018

XtendiMax™ With VaporGrip™ Technology

EPA Reg. No. 524-617

GROUP	4	HERBICIDE

FOR PREEMERGENCE AND POSTEMERGENCE USE ON ROUNDUP READY 2 XTEND® SOYBEANS

Keep out of reach of children

CAUTION!

In case of an emergency involving this product, call collect, day or night, 314-694-4000.

HT3 Soybean – 2020

Glyphosate, Dicamba, Glufosinate

"I can't keep dicamba in the field"

July 18, 2017

Author: Larry Steckel, Extension Weed Specialist 1 Comment

"I can't keep dicamba in the field" has been a frequent comment I have heard from many frustrated folks who have followed the rules and tried their best not to drift on their neighbors. Quite a few good and conscientious farmers have thrown up their hands and gone back to Flexstar to try to control pigweed in soybean. Others have reported that they often have been successful not drifting onto non-target areas. However, judging by all the off-target dicamba injury that seems to be more the exception than the rule.

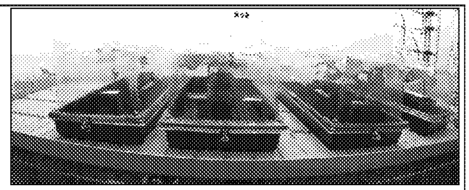
So what are the reasons for all the drift? After visiting hundreds of dicamba-drifted RR, LL and conventional soybean fields that easily have totaled over 30,000 acres, I can say with certainty that many of the reasons I have heard recently from upper management in Monsanto are NOT the cause of all these dicamba injured broadleaf plants across west Tennessee.

I cannot imagine the hundreds of thousands of acres of non dicamba tolerant (DT) soybeans in Tennessee that have shown dicamba injury could be due to contamination of Liberty jugs with dicamba, calcium deficiency, Dual Magnum burn, and/or surfactant burn. Nor do any of those reasons explain the dicamba injury I have seen in a vineyard, gardens, trees in parks and back yards.......even my backyard.

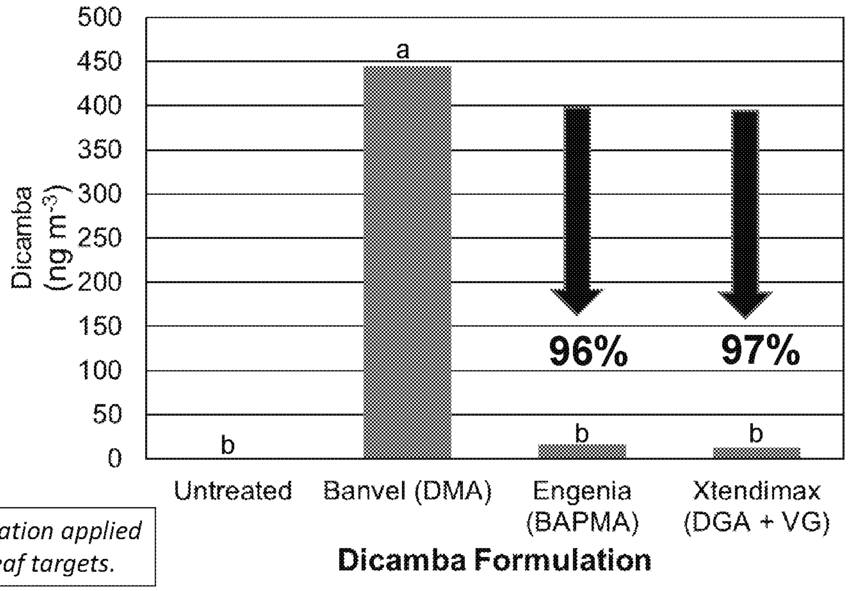
Dr. Larry Steckel

Herbicide Formulation

Vapor Chamber Experiment



Monsanto



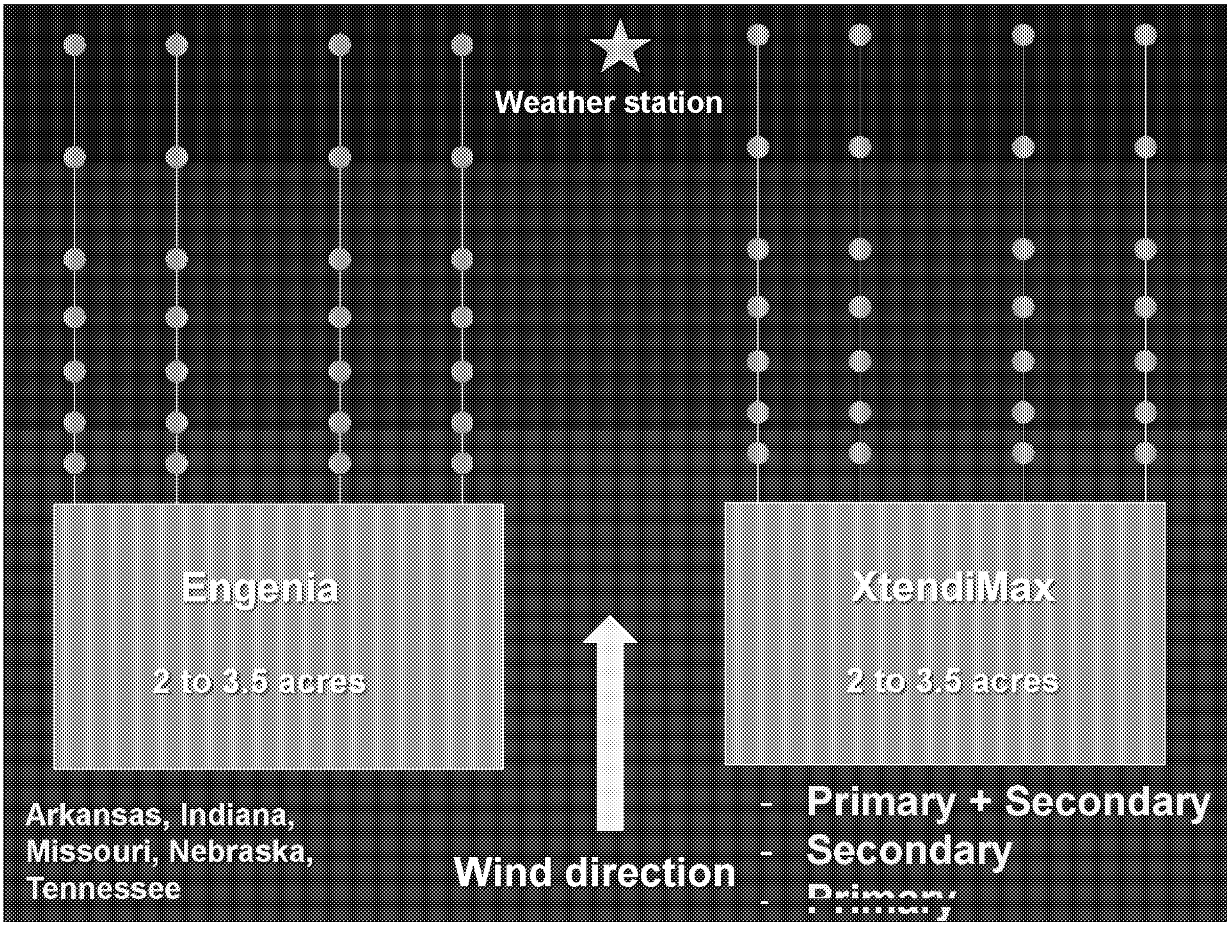
**Banvel formulation applied to soybean leaf targets.*

Dr. Bryan Young

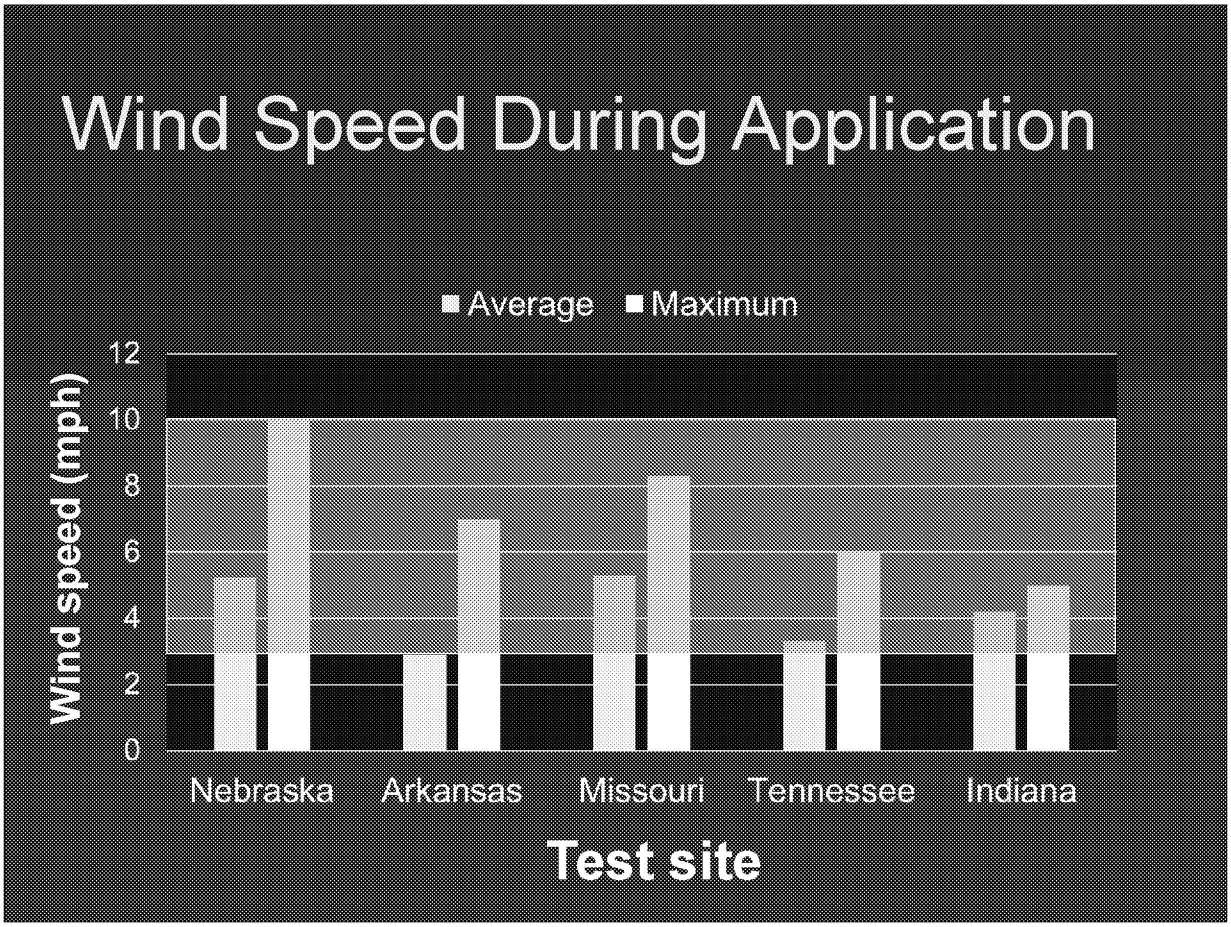
Objectives

- Assess off-target movement of Engenia and XtendiMax in field trials using labeled applications
- To determine if secondary movement contributes significantly to off-target movement of both formulations

Trial locations - 2017



Weather station
Engenia
2 to 3.5 acres
XtendiMax
2 to 3.5 acres
Arkansas, Indiana, Missouri, Nebraska, Tennessee
Wind direction
- Primary + Secondary
- Secondary


Wind Speed During Application
Average
Maximum
Wind speed (mph)
12
10
8
6
4
2
0
Nebraska
Arkansas
Missouri
Tennessee
Indiana
Test site

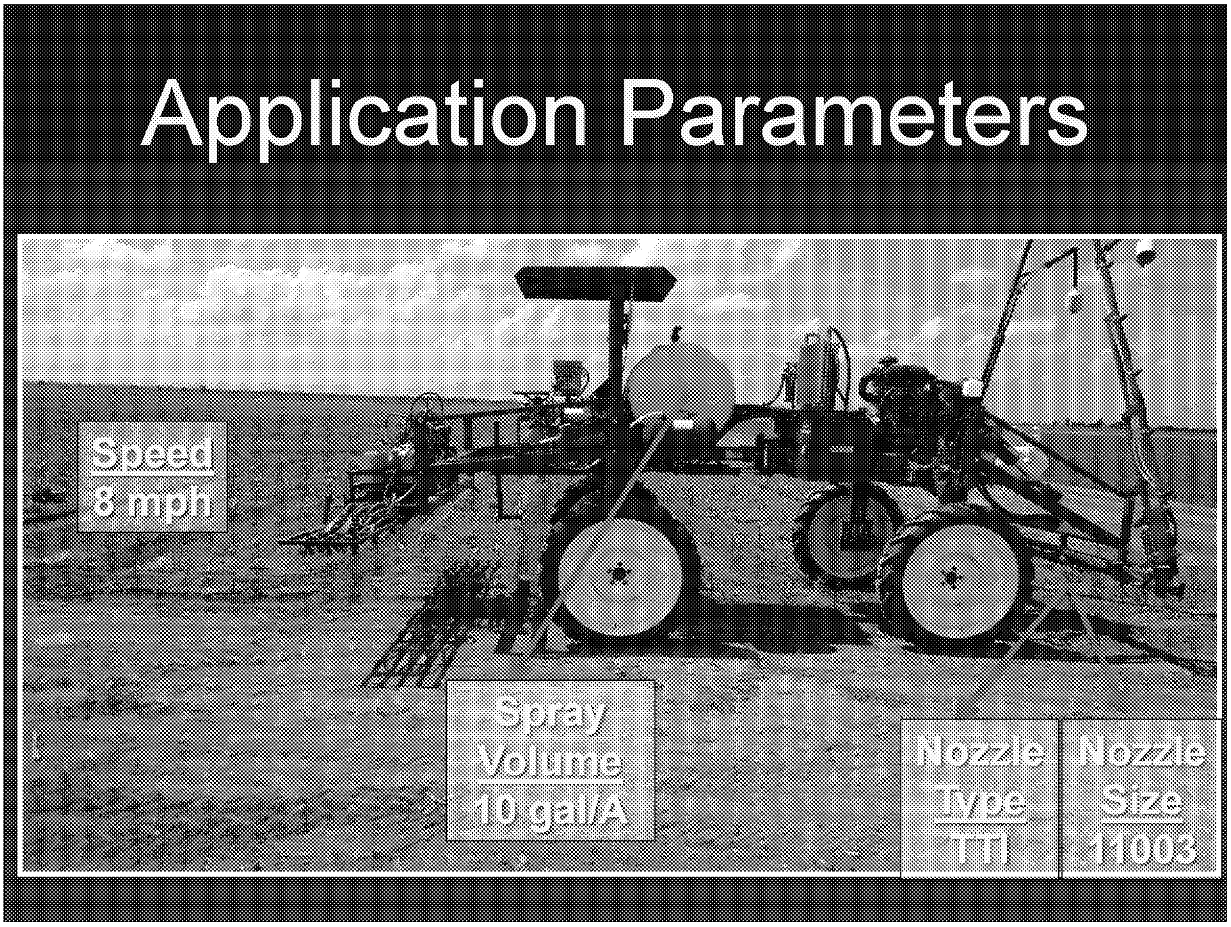
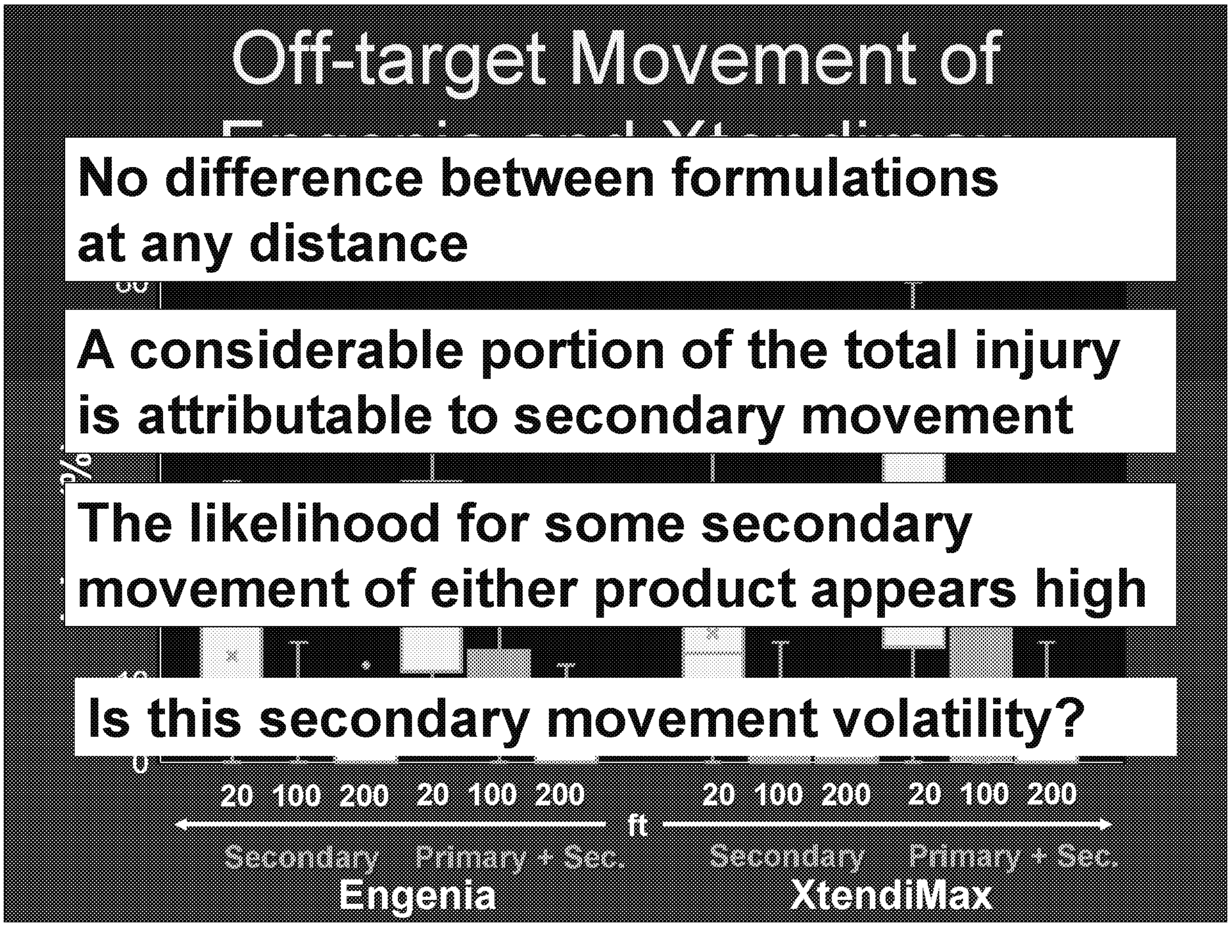
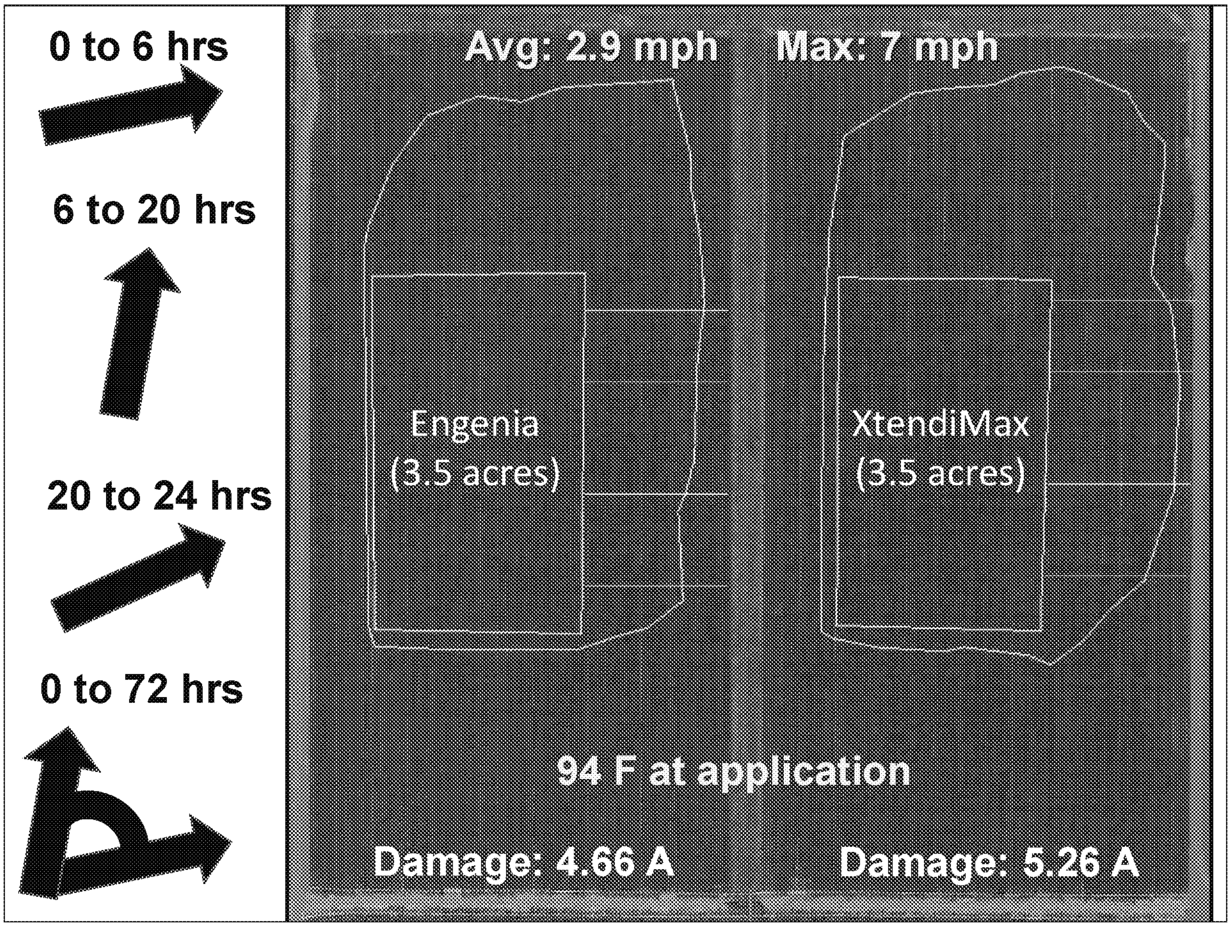
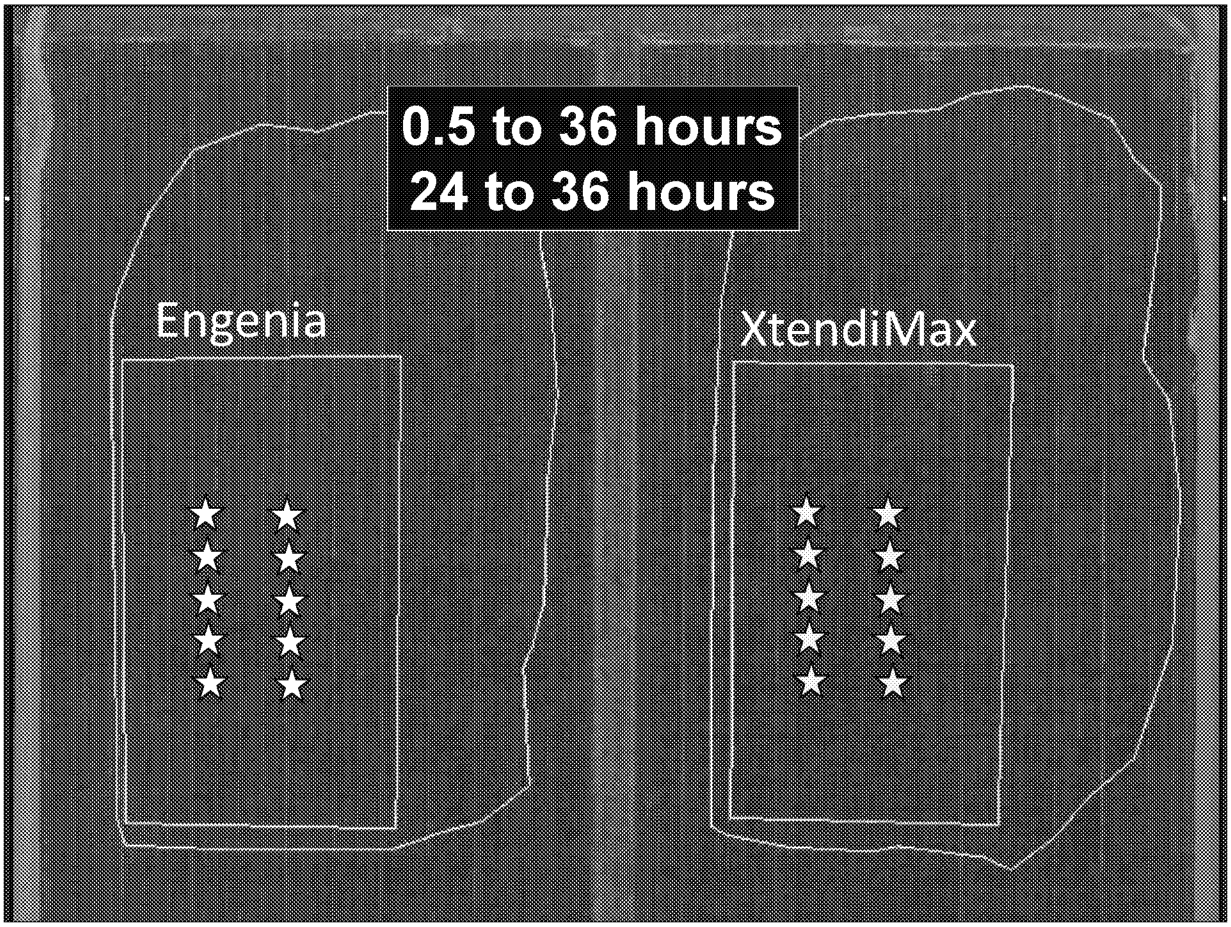


Image in background is a MudMaster. One of the sprayers used to apply treatments


Off-target Movement of
No difference between formulations at any distance
A considerable portion of the total injury is attributable to secondary movement
The likelihood for some secondary movement of either product appears high
Is this secondary movement volatility?
20 100 200 20 100 200 20 100 200 20 100 200
ft
Secondary Primary + Sec. Secondary Primary + Sec.
Engenia
XtendiMax

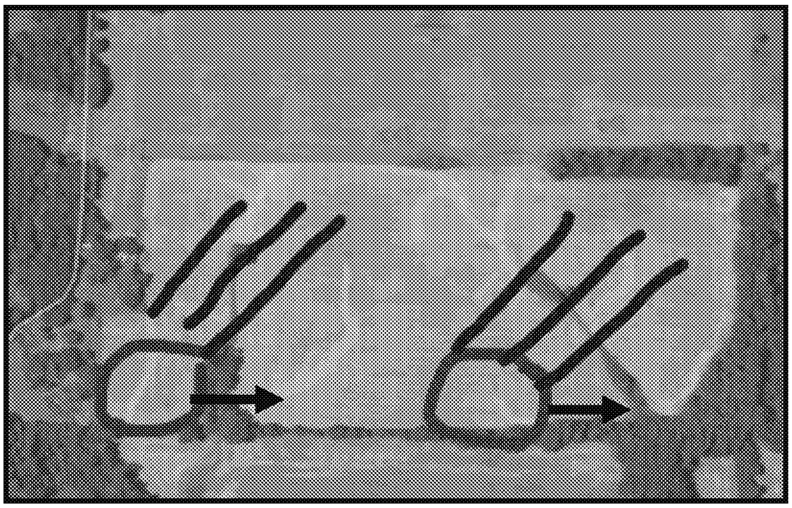

0 to 6 hrs
6 to 20 hrs
20 to 24 hrs
0 to 72 hrs
Avg: 2.9 mph
Max: 7 mph
Engenia
(3.5 acres)
XtendiMax
(3.5 acres)
94 F at application
Damage: 4.66 A
Damage: 5.26 A


0.5 to 36 hours
24 to 36 hours
Engenia
XtendiMax


XtendiMax
0.5 to 36 hours
24 to 36 hours

Drift Showed up Against the Wind Direction when it was Sprayed

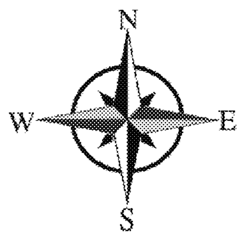
XtendiMax
+ Rdp Pmax + Intact



Engenia
+ Rdp Pmax

>2 hours

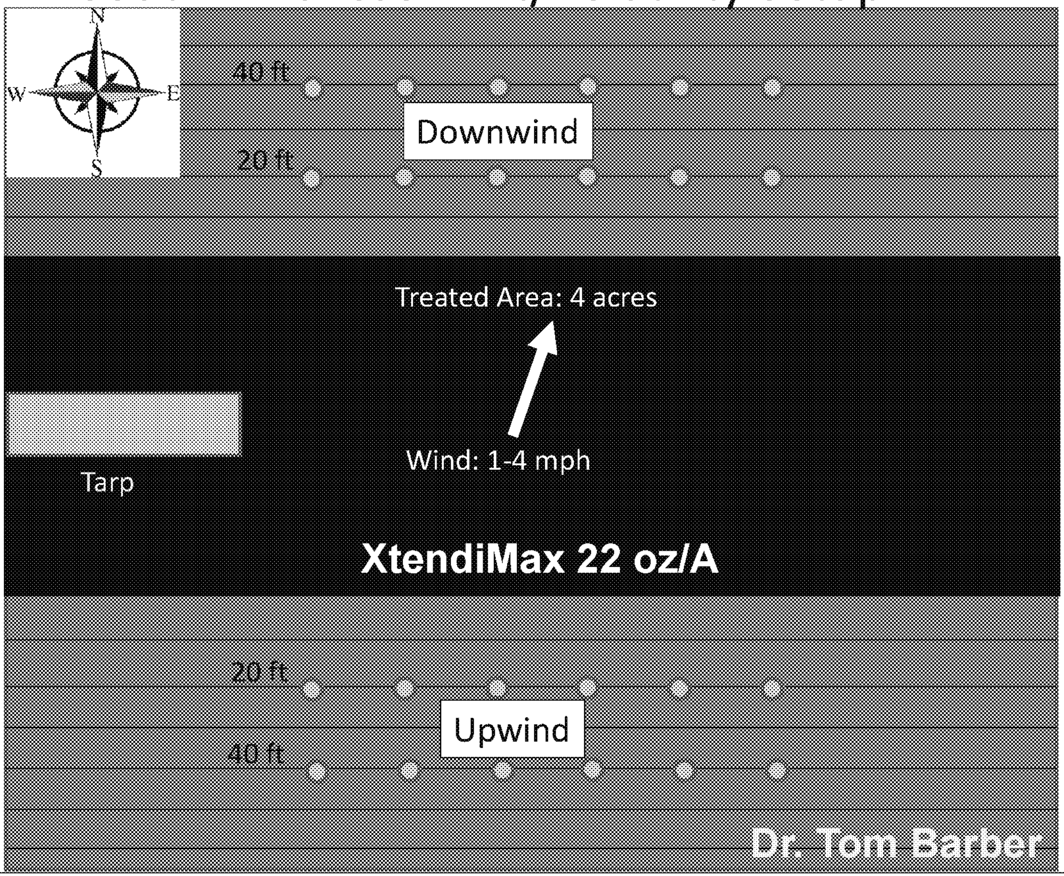
0 to 2 hours



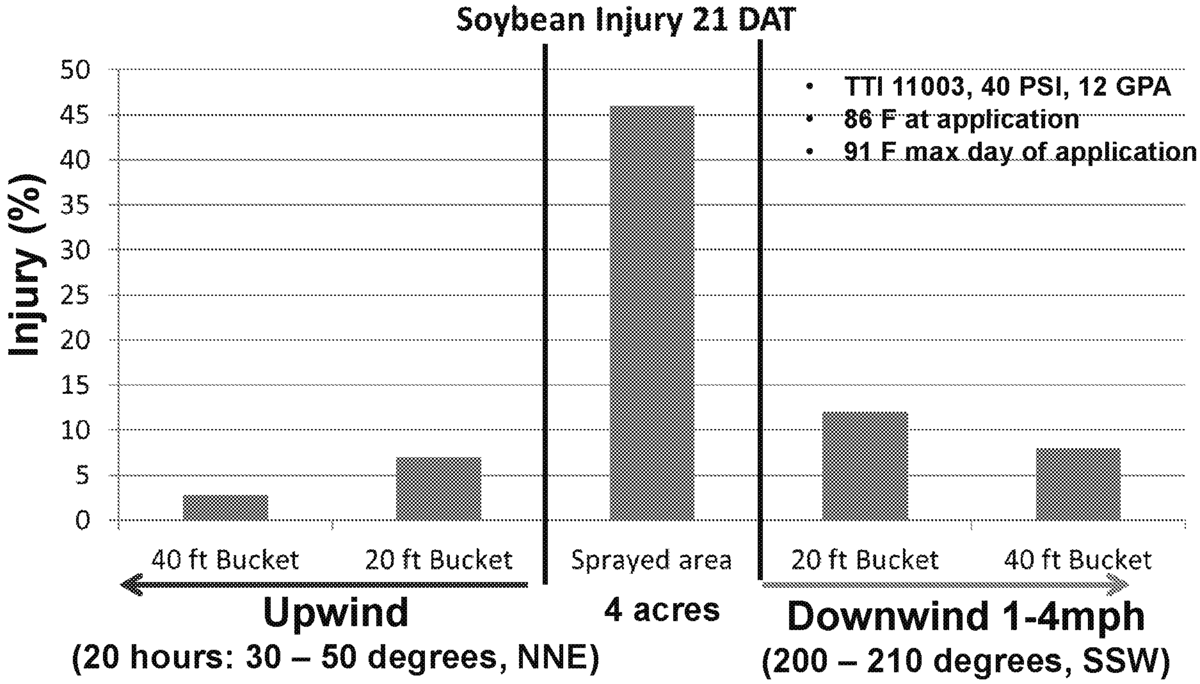
INSTITUTE OF AGRICULTURE
THE UNIVERSITY OF TENNESSEE

Dr. Larry Steckel

South Arkansas Drift/Volatility Setup



20-Acre Drift Study Southern Arkansas
XtendiMax 22 oz/Acre



What Have We Learned?

- Volatility data based on laboratory trials do not match the degree of volatility in the field.
- Research from university weed scientists across the U.S. indicates newer forms of dicamba may volatilize at appreciable levels to cause injury to soybean.
- We can address physical drift through education, but volatility is more challenging to address.

ACCEPTED
11/09/2016
Under the Federal Insecticide, Fungicide and Rodenticide Act as amended, for the pesticide registered under EPA Reg. No. 524-617

SUPPLEMENTAL LABELING

READ THE ENTIRE LABEL FOR XTENDIMAX™ WITH VAPORGRIP™ TECHNOLOGY BEFORE PROCEEDING WITH THE USE DIRECTIONS CONTAINED IN THIS SUPPLEMENTAL LABELING.

When using XtendiMax™ With VaporGrip™ Technology as permitted according to this supplemental labeling, read and follow all applicable directions, restrictions, and precautions on the container label and booklet provided with the product container and on this supplemental labeling. This supplemental labeling must be in the possession of the user at the time of pesticide application.

Label expires on 11/09/2018

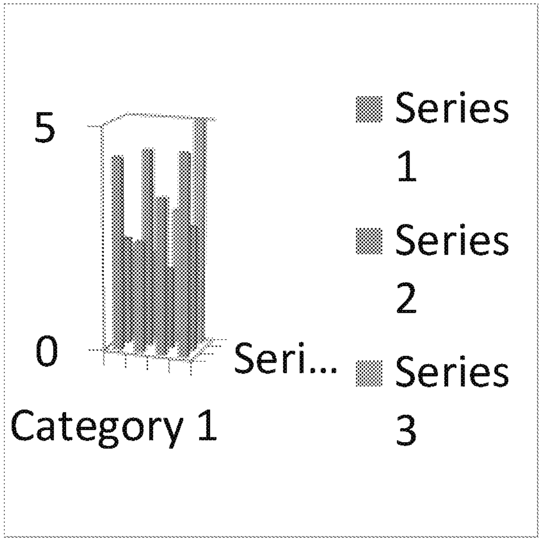
What does a successful 2018 season look like?

Keep out of reach of children

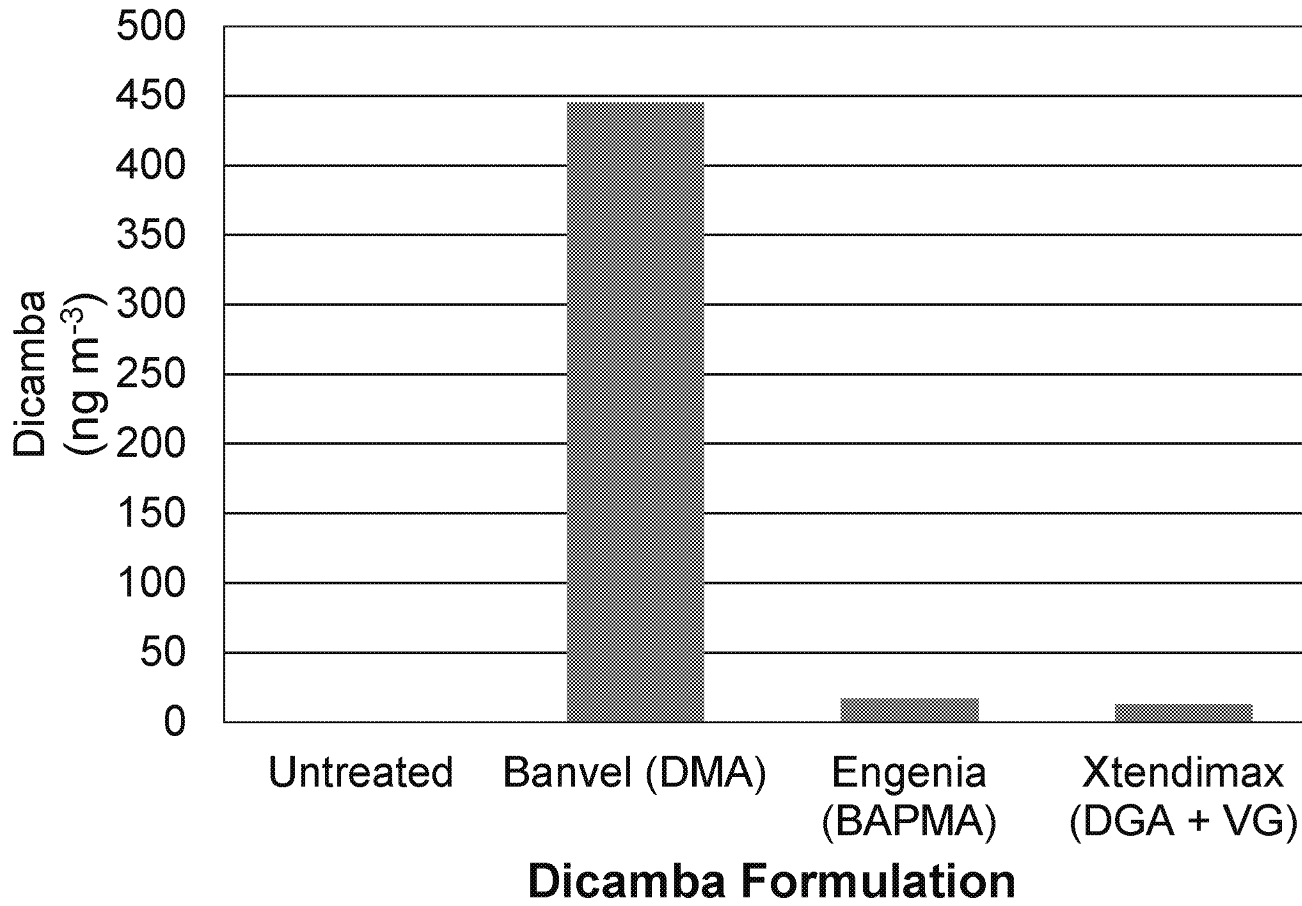
CAUTION!

In case of an emergency involving this product, call collect, day or night, 314-694-4000.

Questions?

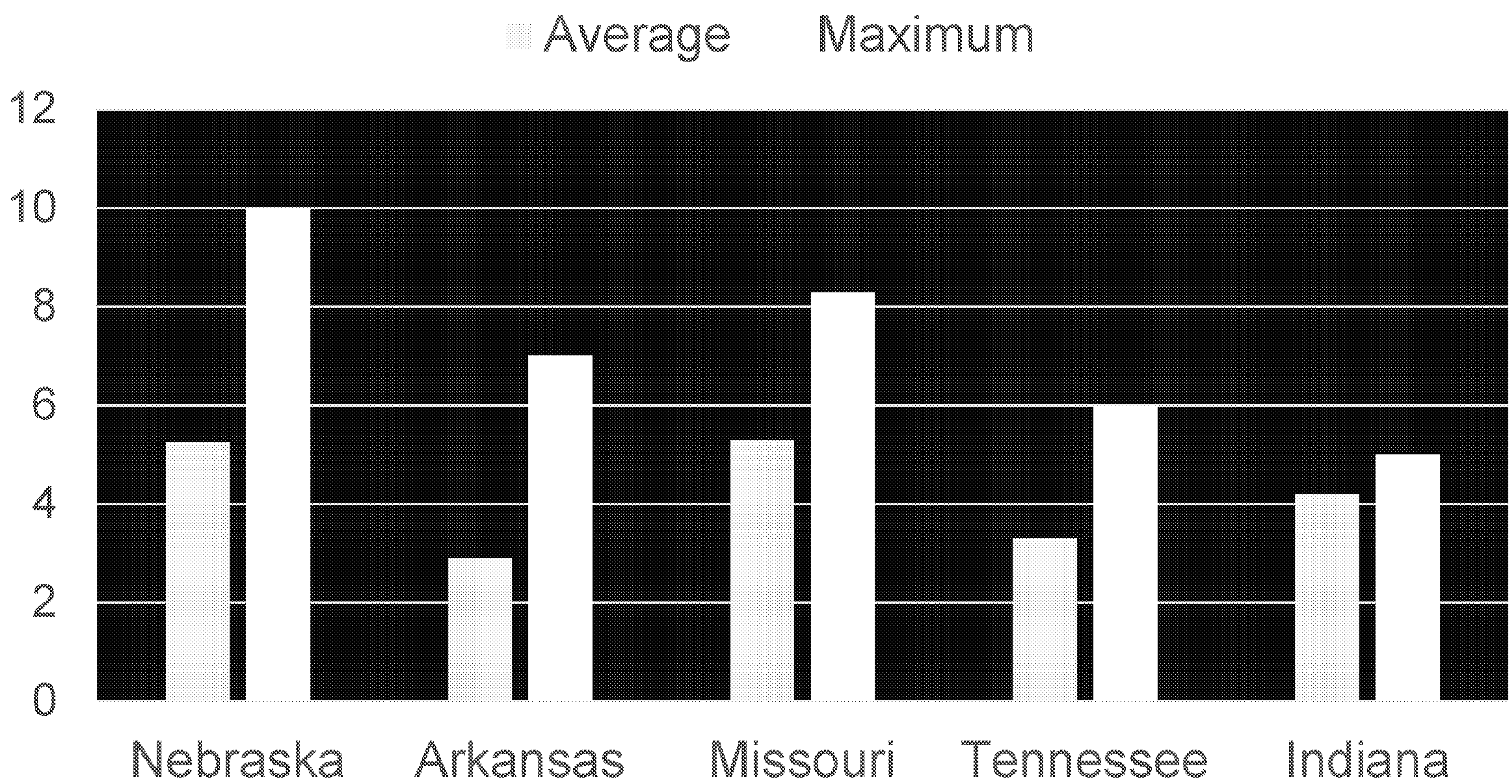

5
0
Category 1
Seri...
Series 1
Series 2
Series 3

	Series 1	Series 2	Series 3
Category 1	4.3	2.4	2
Category 2	2.5	4.4	2
Category 3	3.5	1.8	3
Category 4	4.5	2.8	5

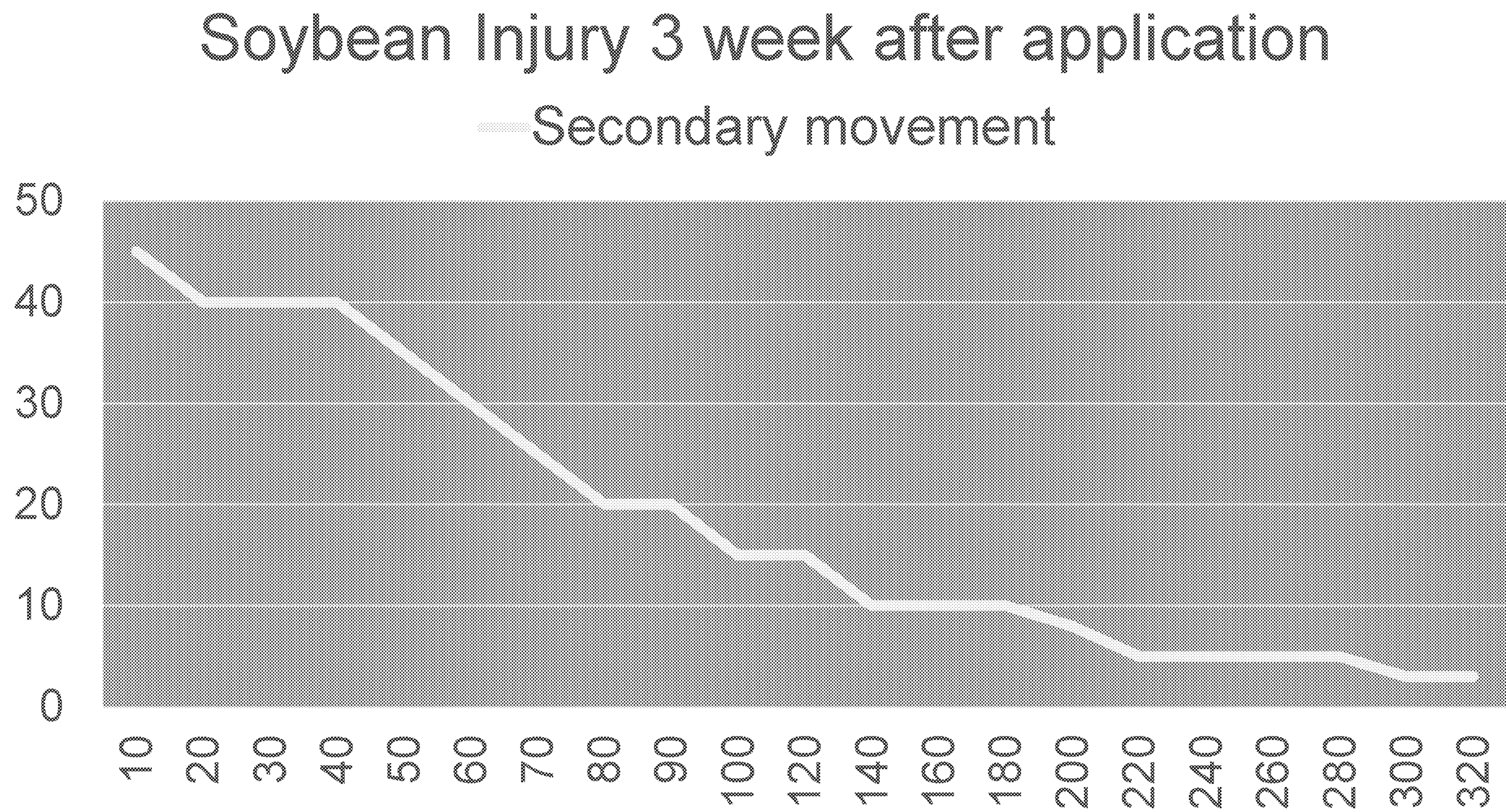


Dicamba (ng m-3)
500
450
400
350
300
250
200
150
100
50
0
Untreated
Banvel (DMA)
Engenia (BAPMA)
Xtendimax (DGA + VG)
Dicamba Formulation

formulation	Column1
Untreated	0
Banvel (DMA)	445
Engenia (BAPMA)	17
Xtendimax (DGA + VG)	13

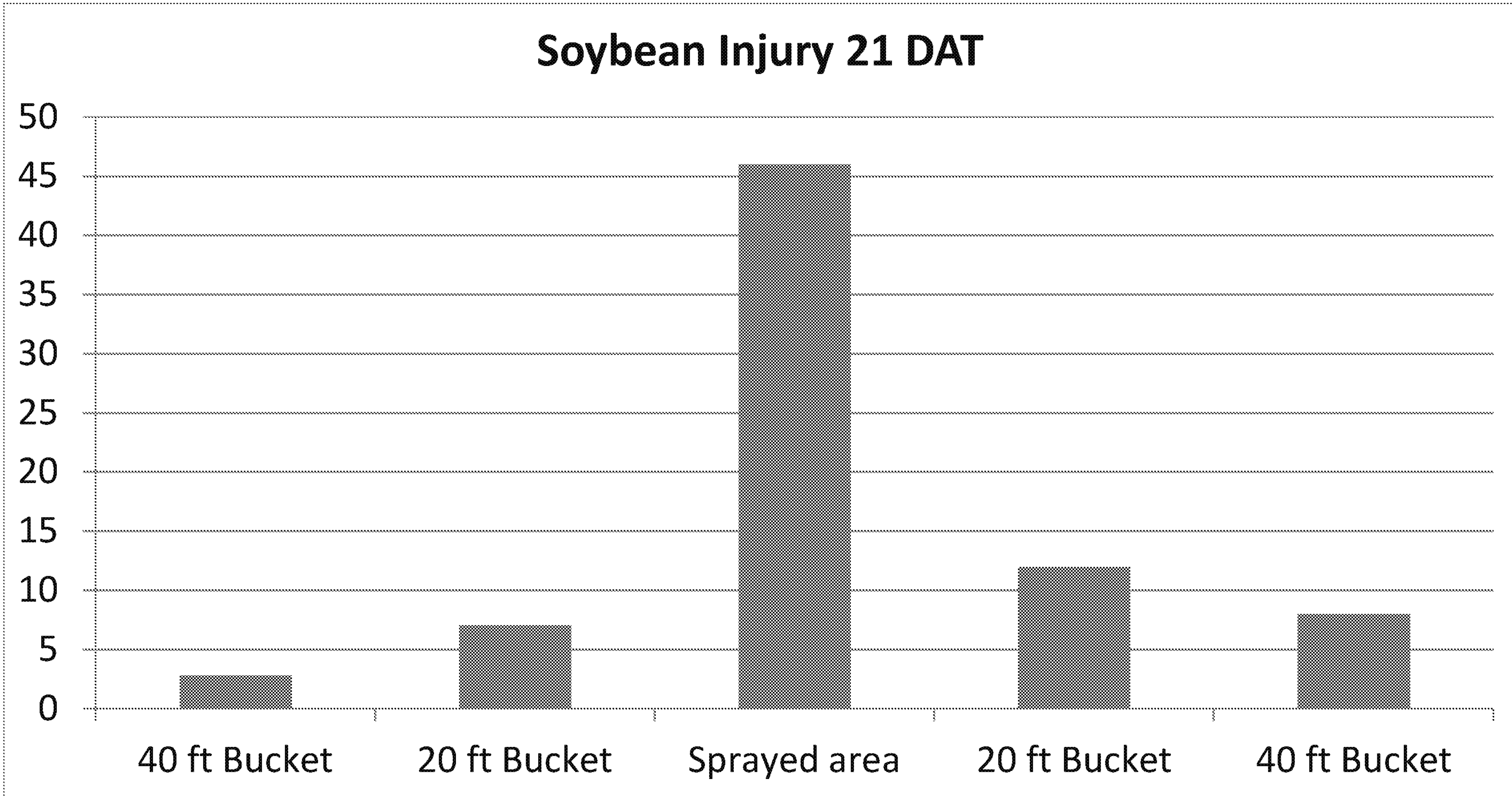

Average
Maximum
12
10
8
6
4
2
0
Nebraska
Arkansas
Missouri
Tennessee
Indiana

	Average	Maximum
Nebraska	5.25	10
Arkansas	2.9	7
Missouri	5.3	8.3
Tennessee	3.3	6
Indiana	4.2	5



Soybean Injury 3 week after application
Secondary movement
50
40
30
20
10
0
10
20
30
40
50
60
70
80
90
100
120
140
160
180
200
220
240
260
280
300
320

	Secondary movement
10	45
20	40
30	40
40	40
50	35
60	30
70	25
80	20
90	20
100	15
120	15
140	10
160	10
180	10
200	8
220	5
240	5
260	5
280	5
300	3
320	3


Soybean Injury 21 DAT
50
45
40
35
30
25
20
15
10
5
0
40 ft Bucket
20 ft Bucket
Sprayed area
20 ft Bucket
40 ft Bucket

	Soybean Injury	Series 2	Series 3
40 ft Bucket	2.8	2.4	2
20 ft Bucket	7	1.8	3
Sprayed area	46		
20 ft Bucket	12		
40 ft Bucket	8		

20.83333333	37.08333333	7.083333333	21.25

Message

From: Susie Nichols [Susie.Nichols@aspb.ar.gov]
Sent: 3/7/2018 1:45:12 PM
To: Kenny, Daniel [Kenny.Dan@epa.gov]
CC: jnorswor@uark.edu

Dan

Dr Jason Norsworthy said give him a call about the research you need.

479-313-1265

Sent from my iPhone

Message

From: Scott Senseman (via Google Docs) [ssensema@gmail.com]
Sent: 5/30/2018 8:51:04 PM
To: Kenny, Daniel [Kenny.Dan@epa.gov]
CC: chad.asmus@basf.com; marathonag@zianet.com; Baris, Reuben [Baris.Reuben@epa.gov]; Bradleyke@missouri.edu; jbunting@growmark.com; arlene.cotie@bayer.com; stanley@uga.edu; rgrant@purdue.edu; hager@illinois.edu; a.hewitt@uq.edu.au; Keigwin, Richard [Keigwin.Richard@epa.gov]; gkruger2@unl.edu; BNichols@cottoninc.com; jnorswor@uark.edu; jeanp@ifca.com; Peck, Charles [Peck.Charles@epa.gov]; jreiss@precisionlab.com; dreynolds@pss.msstate.edu; ssensema@utk.edu; ssmith@redgold.com; lsteckel@utk.edu; hthistle@fs.fed.us; Lee.VanWychen@wssa.net; Jweirich@mfa-inc.com; Sid Abel [Sidney.W.Abel@aphis.usda.gov]
Subject: Dicamba Report_May 30.docx - Invitation to comment

Scott Senseman has invited you to **comment on** the following document:

Dicamba Report_May 30.docx

Open in Docs

Message

From: Scott Senseman (via Google Docs) [ssensema@gmail.com]
Sent: 5/30/2018 8:43:37 PM
To: Kenny, Daniel [Kenny.Dan@epa.gov]
CC: Sid Abel [Sidney.W.Abel@aphis.usda.gov]; chad.asmus@basf.com; marathonag@zianet.com; Baris, Reuben [Baris.Reuben@epa.gov]; Bradleyke@missouri.edu; jbunting@growmark.com; arlene.cotie@bayer.com; stanley@uga.edu; jferrell@ufl.edu; rgrant@purdue.edu; hager@illinois.edu; a.hewitt@uq.edu.au; gkruger2@unl.edu; rleon@ncsu.edu; BNichols@cottoninc.com; jnorswor@uark.edu; jeanp@ifca.com; jreiss@precisionlab.com; dreynolds@pss.msstate.edu; ssensema@utk.edu; DShaw@research.msstate.edu; wgs@turbodrop.com; ssmith@redgold.com; lsteckel@utk.edu; hthistle@fs.fed.us; Lee.VanWychen@wssa.net; Jweirich@mfa-inc.com; Keigwin, Richard [Keigwin.Richard@epa.gov]; Peck, Charles [Peck.Charles@epa.gov]
Subject: Dicamba Report_May 30.docx - Invitation to edit

Scott Senseman has invited you to **edit** the following document:

Dicamba Report_May 30.docx

Dear Invitees and Participants,

Once again, I would like to thank all of you for being willing to participate in our April workshop in DC to discuss herbicide off-target movement. I believe that it was a very productive meeting and we hope to have a set of positive outcomes going forward. Our writing committee has done a great deal of work to capture the points made at the meeting and to provide a comprehensive report for your review. We very much would like to keep the review process short and to get feedback from this group in the next 7 days (by June 6, 2018 Close of Business). Upon that deadline, we will be sending it to two WSSA Committees, 1) Formulations, Adjuvants, and Application Technology and 2) Environmental Aspects for their input in the same timeframe. Finally, we will send the edited version to the registrants and ultimately to our webpage for display over the next several weeks.

I am planning to use Google Docs to facilitate the review process. The document can be accessed at this link. We have also created a link to all of the PDF files of the 11 presentations that were made at the Workshop. Any comments that you would like to provide will show up as suggested edits or you can add comments through the "insert" menu. If you have any issues seeing the document, please let me know and I will try another method.

Thank you again for helping us understand the data gaps related to this technology. We will do our best to use this information to the betterment of our producers and scientific discipline.

Sincerely,

Scott SensemanPresident, Weed Science Society of America

Scott A. Senseman
Professor and Department Head
Department of Plant Sciences
2431 Joe Johnson Drive, 252 Ellington Plant Sciences Building
Knoxville, Tennessee 37996

865-974-8033 Office / 865-974-1947 Fax
scottsenseman@tennessee.edu | https://ag.tennessee.edu/plantsciences

Follow on Twitter - @UTPSDeptHead
Follow Plant Sciences on Twitter - @utkplsc

Like Plant Sciences on Facebook - utkplsc
Keep in touch with alumni! Add Plant Sciences to your LinkedIN Profile https://lnkd.in/dANBcuz
Open in Docs

Message

From: Rosenblatt, Daniel [Rosenblatt.Dan@epa.gov]
Sent: 9/10/2018 9:47:00 PM
To: jnorswor@uark.edu
CC: Kenny, Daniel [Kenny.Dan@epa.gov]
Subject: formulation info

Jason – do you happen to have formulation specific data on dicamba flux in any of your trials that you could send to EPA? I am especially interested in information on the new formulations. Thanks for looking into this.

Dan

Daniel J. Rosenblatt, Deputy Director,
Registration Division, Office of Pesticide Programs
Rosenblatt.dan@epa.gov
703-308-9366

Message

From: Rosenblatt, Daniel [Rosenblatt.Dan@epa.gov]
Sent: 9/10/2018 9:05:29 PM
To: jnorsworthy@uaex.edu
CC: Kenny, Daniel [Kenny.Dan@epa.gov]
Subject: formulation info

Jason – do you happen to have formulation specific data on dicamba flux in any of your trials that you could send to EPA? I am especially interested in information on the new formulations. Thanks for looking into this.

Dan

Daniel J. Rosenblatt, Deputy Director,
Registration Division, Office of Pesticide Programs
Rosenblatt.dan@epa.gov
703-308-9366

Message

From: Rosenblatt, Daniel [Rosenblatt.Dan@epa.gov]
Sent: 9/11/2018 3:13:57 PM
To: Jason Keith Norsworthy [jnorswor@uark.edu]; Kenny, Daniel [Kenny.Dan@epa.gov]
Subject: RE: formulation info

Great – thank you

From: Jason Keith Norsworthy [mailto:jnorswor@uark.edu]
Sent: Tuesday, September 11, 2018 11:03 AM
To: Kenny, Daniel <Kenny.Dan@epa.gov>; Rosenblatt, Daniel <Rosenblatt.Dan@epa.gov>
Subject: RE: formulation info

Guys,

Here is the Environmental Data and the actual assessments for the 5 large-plot trials comparing XtendiMax to Engenia in 2017.

Regards,
Jason

Jason Norsworthy, PhD
Professor and Elms Farming Chair of Weed Science
1366 West Altheimer Dr.
Fayetteville, AR 72704
Tel: 479-575-8740
Mob: 479-313-1265

From: Kenny, Daniel <Kenny.Dan@epa.gov>
Sent: Monday, September 10, 2018 9:28 PM
To: Rosenblatt, Daniel <Rosenblatt.Dan@epa.gov>
Cc: Jason Keith Norsworthy <jnorswor@uark.edu>
Subject: Re: formulation info

Thanks Jason, this is very much appreciated! We'll take a look and then follow up with you. In the meantime, I hope all is well with you.

Thanks again,
Dan

Sent from my iPhone

On Sep 10, 2018, at 5:47 PM, Rosenblatt, Daniel <Rosenblatt.Dan@epa.gov> wrote:

> Jason – do you happen to have formulation specific data on dicamba flux in any of your trials that you could send to EPA? I am especially interested in information on the new formulations. Thanks for looking into this.

Dan

Daniel J. Rosenblatt, Deputy Director,
Registration Division, Office of Pesticide Programs
Rosenblatt.dan@epa.gov
703-308-9366

Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 9/11/2018 3:02:46 PM
To: Kenny, Daniel [Kenny.Dan@epa.gov]; Rosenblatt, Daniel [Rosenblatt.Dan@epa.gov]
Subject: RE: formulation info
Attachments: Data Across Locations.xlsx; Environmental Application Agronomic Info.xls

Guys,

Here is the Environmental Data and the actual assessments for the 5 large-plot trials comparing XtendiMax to Engenia in 2017.

Regards,
Jason

Jason Norsworthy, PhD
Professor and Elms Farming Chair of Weed Science
1366 West Altheimer Dr.
Fayetteville, AR 72704
Tel: 479-575-8740
Mob: 479-313-1265

From: Kenny, Daniel <Kenny.Dan@epa.gov>
Sent: Monday, September 10, 2018 9:28 PM
To: Rosenblatt, Daniel <Rosenblatt.Dan@epa.gov>
Cc: Jason Keith Norsworthy <jnorswor@uark.edu>
Subject: Re: formulation info

Thanks Jason, this is very much appreciated! We'll take a look and then follow up with you. In the meantime, I hope all is well with you.

Thanks again,
Dan

Sent from my iPhone

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> Jason – do you happen to have formulation specific data on dicamba flux in any of your trials that you could send to EPA? I am especially interested in information on the new formulations. Thanks for looking into this.
>
> Dan
>
> Daniel J. Rosenblatt, Deputy Director,
> Registration Division, Office of Pesticide Programs
> Rosenblatt.dan@epa.gov
> 703-308-9366

Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 9/10/2018 10:31:00 PM
To: Rosenblatt, Daniel [Rosenblatt.Dan@epa.gov]
CC: Kenny, Daniel [Kenny.Dan@epa.gov]
Subject: RE: formulation info
Attachments: Norsworthy_Germany_(EPA).ppt

Dan & Dan,

I will have flux data for 2018 for several trials but it will be another 3 to 4 months before that data are available. Tom Mueller is running the analysis. The chemist from MS State is running samples from the Monsanto study conducted in Arkansas, Alabama, Wisconsin, etc. I assume she will have the samples completed within the next few weeks. I suggest that you check with Monsanto (Bayer) or Dan Reynolds on that.

Attached are some slides summarizing the 2017 large-field trial conducted at Arkansas, Nebraska, Tennessee, Indiana, and Missouri looking at secondary movement of Xtendimax and Engenia. I can send you the actual data on soybean injury as well as environmental data for these studies if needed. Look at the slides and let me know. On slide 7, the white lines indicate the periphery of 5% damage to soybean.

Also, as I mentioned, I suggest you contact Dan Reynolds about comparing formulations in low tunnel trials. I just

---

From: Rosenblatt, Daniel <Rosenblatt.Dan@epa.gov>
Sent: Monday, September 10, 2018 4:47 PM
To: Jason Keith Norsworthy <jnorswor@uark.edu>
Cc: Kenny, Daniel <Kenny.Dan@epa.gov>
Subject: formulation info

Jason – do you happen to have formulation specific data on dicamba flux in any of your trials that you could send to EPA? I am especially interested in information on the new formulations. Thanks for looking into this.

Dan

Daniel J. Rosenblatt, Deputy Director,
Registration Division, Office of Pesticide Programs
Rosenblatt.dan@epa.gov
703-308-9366

Secondary movement of XendiMax and Engenia in Drift Trials

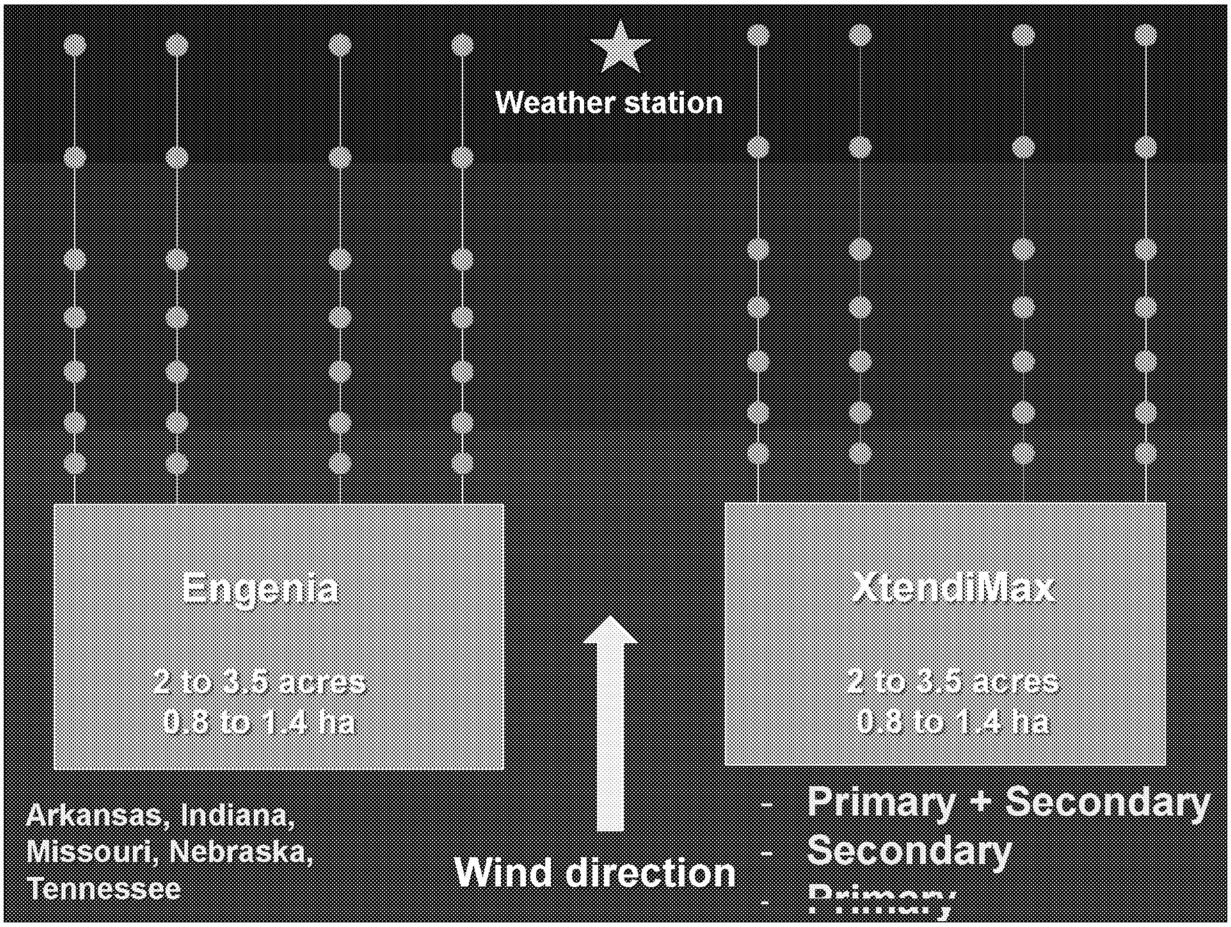
Jason K. Norsworthy

Professor and Endowed Chair of Weed Science

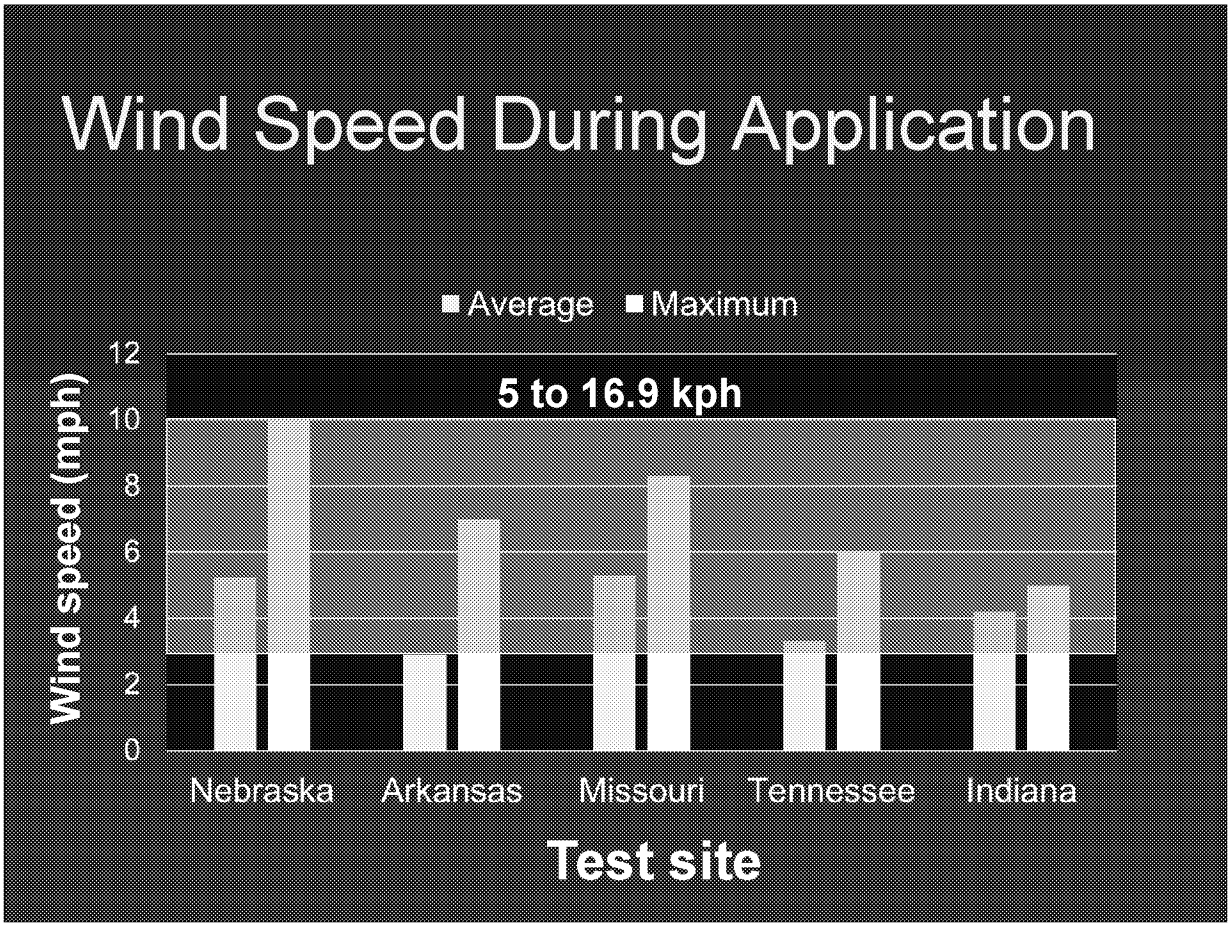
Objectives

- Assess off-target movement of Engenia and XtendiMax in field trials using labeled applications
- To determine if secondary movement contributes significantly to off-target movement of both formulations

Trial locations - 2017



Weather station
Engenia
2 to 3.5 acres
0.8 to 1.4 ha
XtendiMax
2 to 3.5 acres
0.8 to 1.4 ha
Arkansas, Indiana, Missouri, Nebraska, Tennessee
Wind direction
- Primary + Secondary
- Secondary



Wind Speed During Application
Average
Maximum
5 to 16.9 kph
Wind speed (mph)
12
10
8
6
4
2
0
Nebraska
Arkansas
Missouri
Tennessee
Indiana
Test site

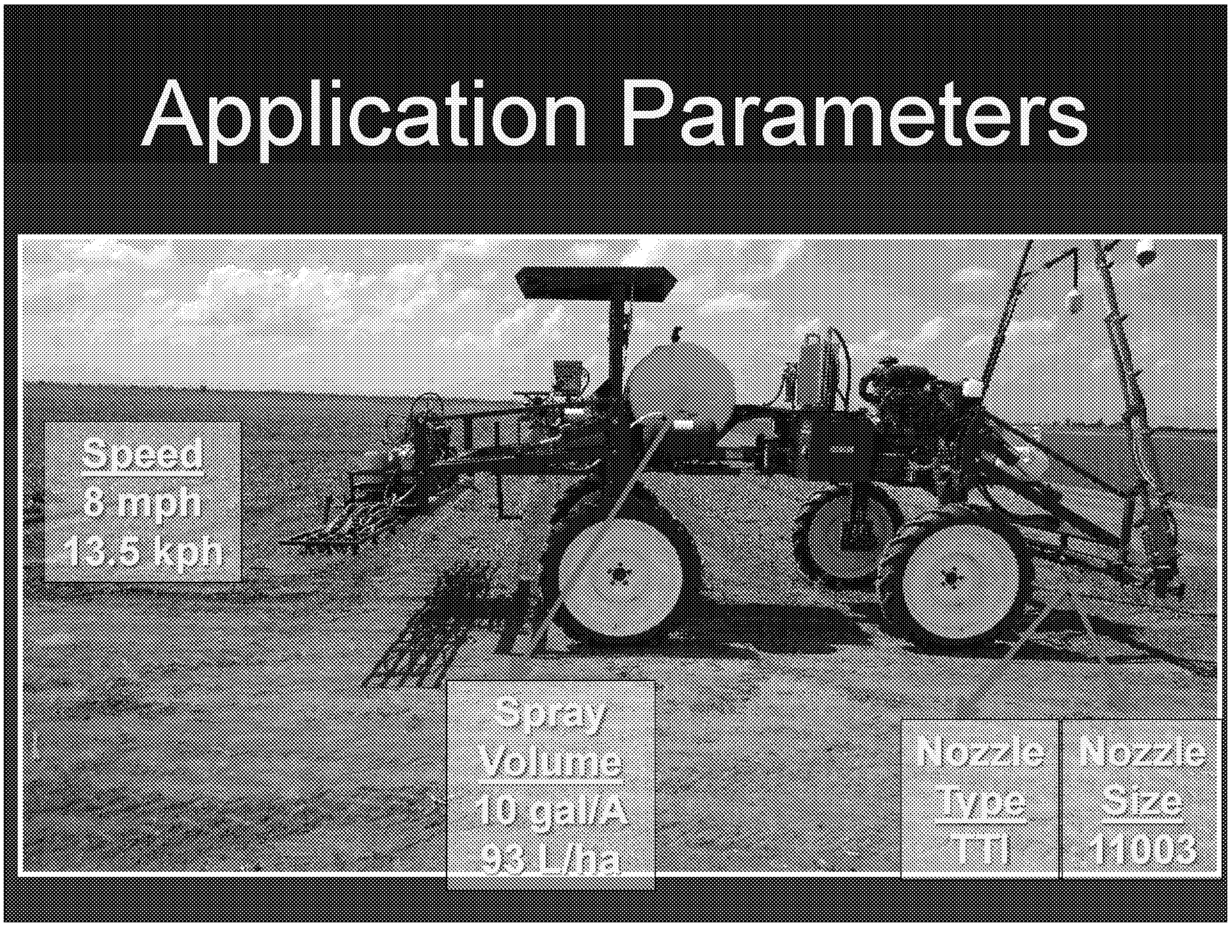
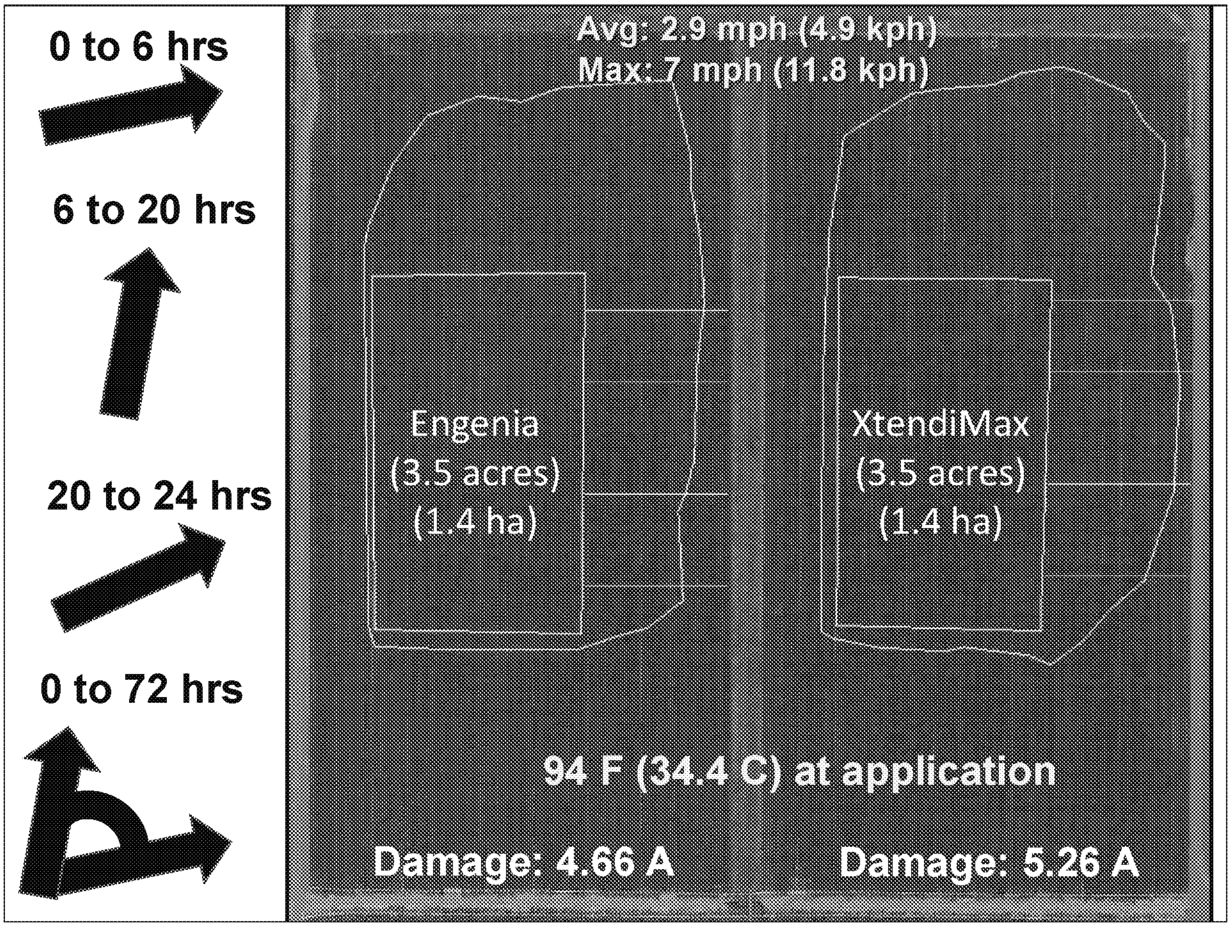
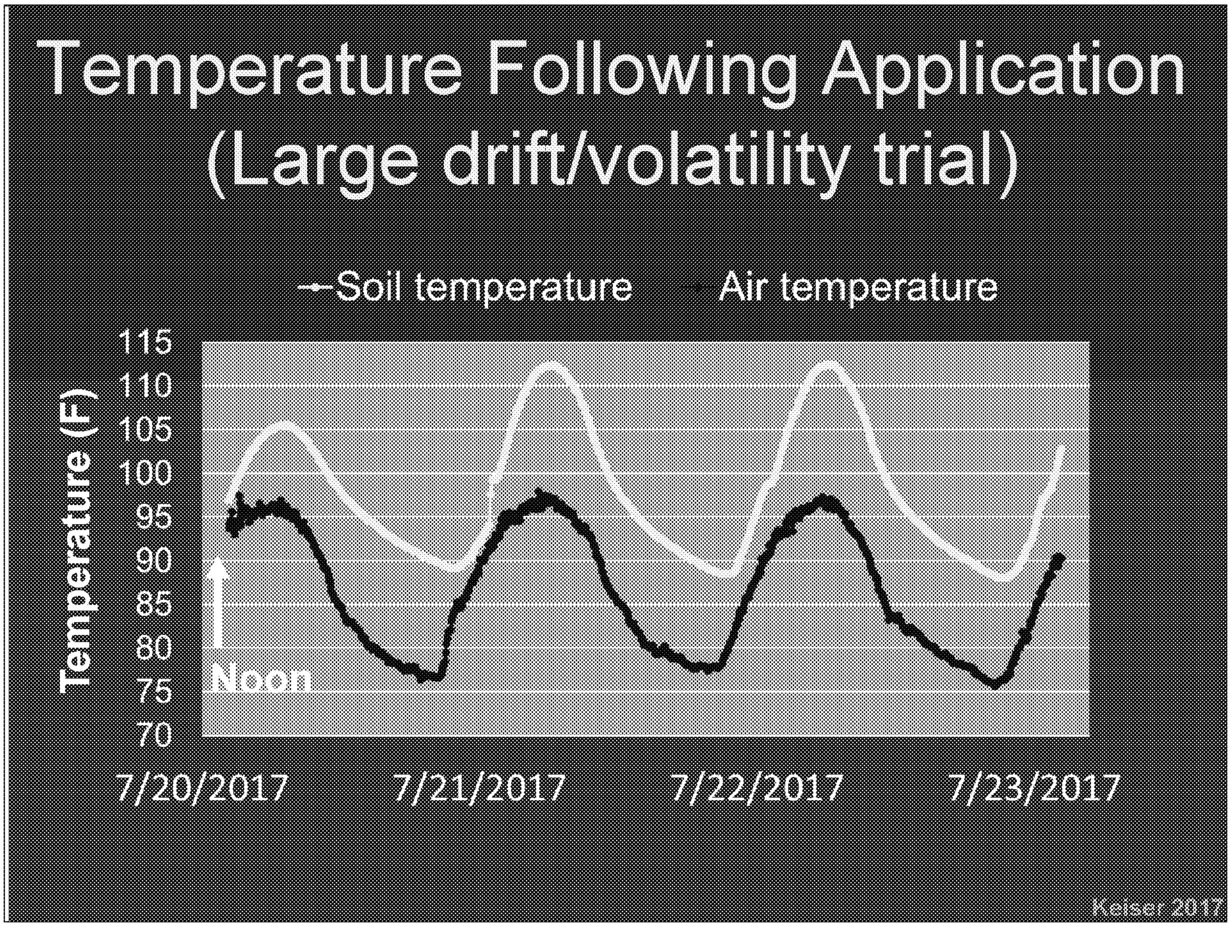
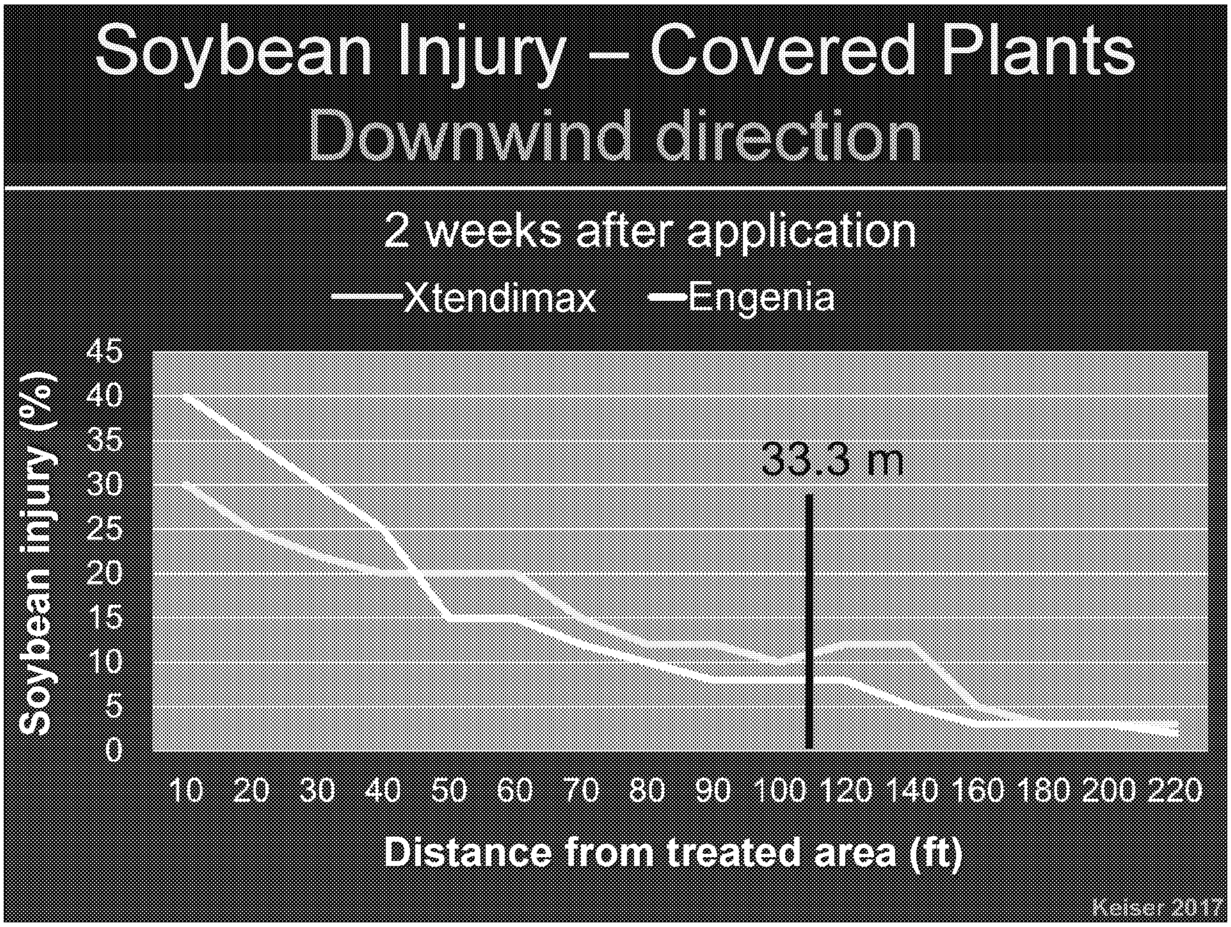


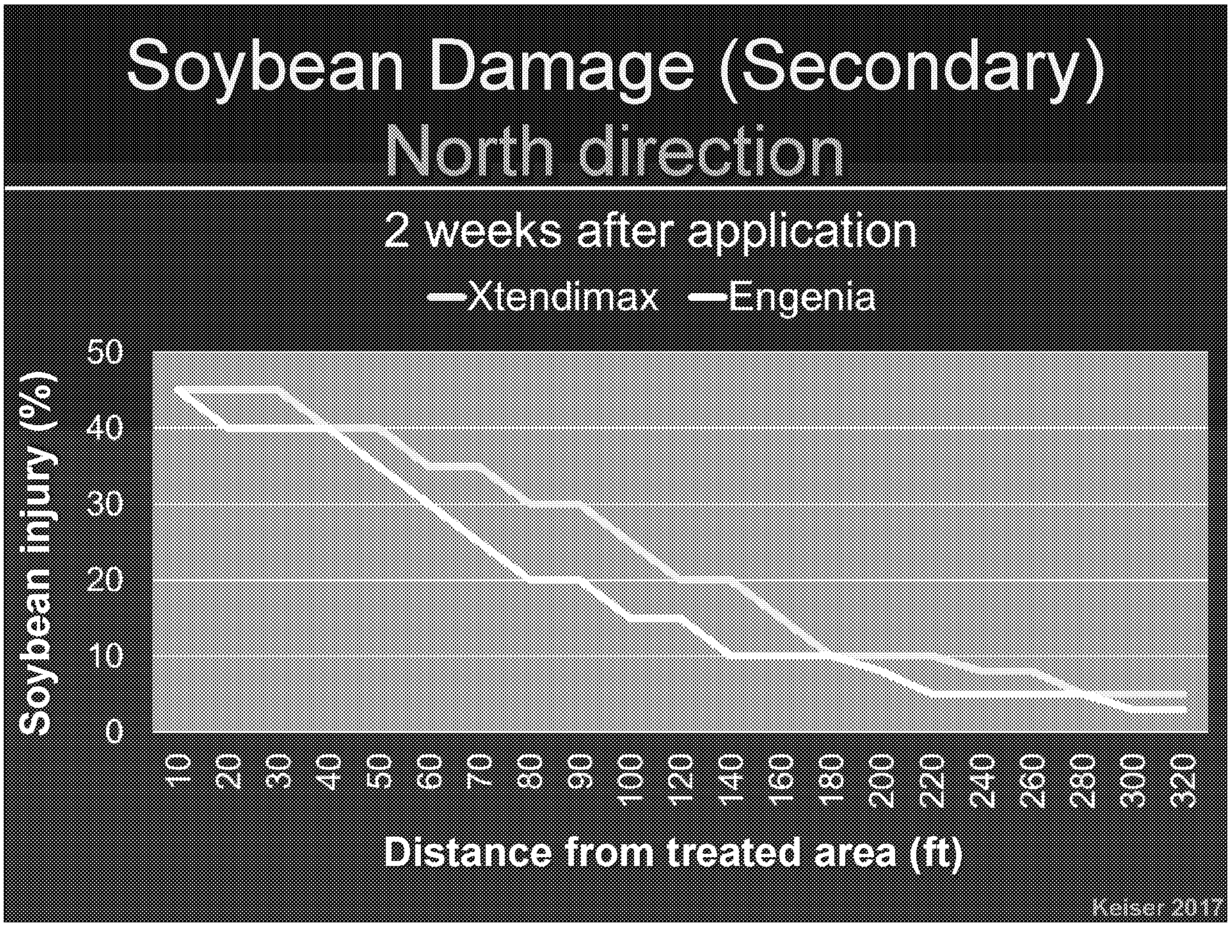
Image in background is a MudMaster. One of the sprayers used to apply treatments

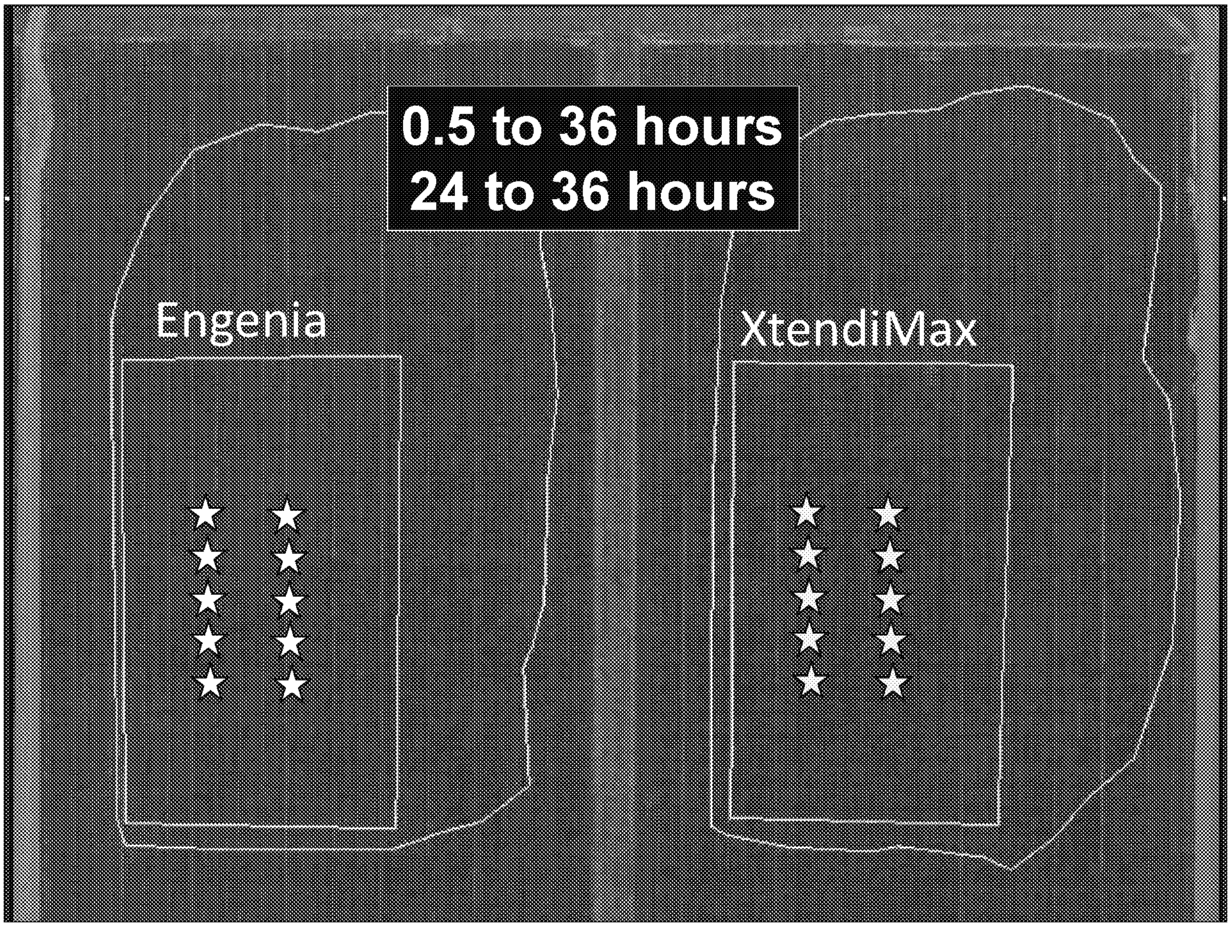

0 to 6 hrs
6 to 20 hrs
20 to 24 hrs
0 to 72 hrs
Avg: 2.9 mph (4.9 kph)
Max: 7 mph (11.8 kph)
Engenia
(3.5 acres)
(1.4 ha)
XtendiMax
(3.5 acres)
(1.4 ha)
94 F (34.4 C) at application
Damage: 4.66 A
Damage: 5.26 A


Temperature Following Application
(Large drift/volatility trial)
Soil temperature
Air temperature
115
110
105
100
95
90
85
80
75
70
Temperature (F)
Noon
7/20/2017
7/21/2017
7/22/2017
7/23/2017
Keiser 2017



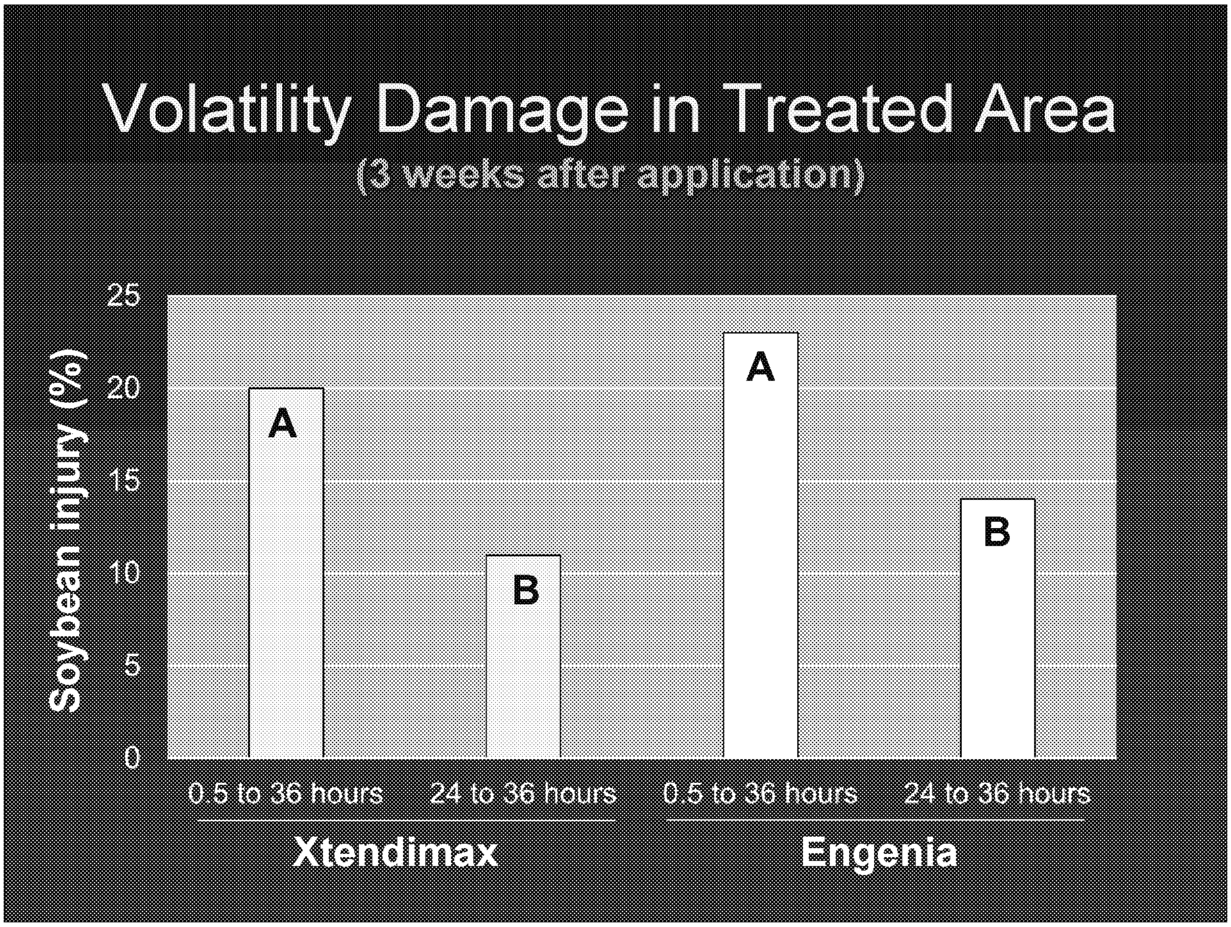
Soybean Injury – Covered Plants
Downwind direction
2 weeks after application
Xtendimax
Engenia
Soybean injury (%)
45
40
35
30
25
20
15
10
5
0
33.3 m
10 20 30 40 50 60 70 80 90 100 120 140 160 180 200 220
Distance from treated area (ft)
Keiser 2017


Soybean Damage (Secondary)
North direction
2 weeks after application
Xtendimax
Engenia
Soybean injury (%)
50
40
30
20
10
0
10
20
30
40
50
60
70
80
90
100
120
140
160
180
200
220
240
260
280
300
320
Distance from treated area (ft)
Keiser 2017


0.5 to 36 hours
24 to 36 hours
Engenia
XtendiMax

XtendiMax

0.5 to 36 hours **24 to 36 hours**

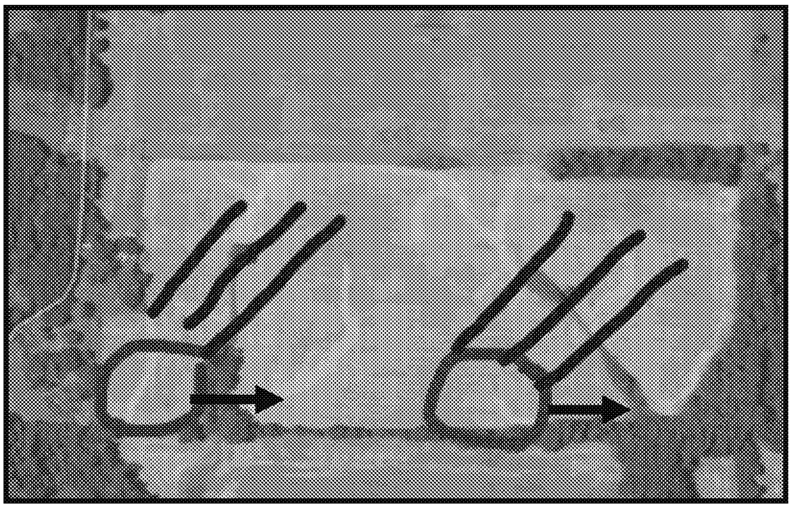

Volatility Damage in Treated Area
(3 weeks after application)
Soybean injury (%)
25
20
15
10
5
0
A
B
A
B
0.5 to 36 hours
24 to 36 hours
0.5 to 36 hours
24 to 36 hours
Xtendimax
Engenia

Drift Showed up Against the Wind Direction when it was Sprayed

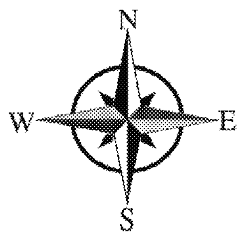
XtendiMax
+ Rdp Pmax + Intact

>2 hours

0 to 2 hours

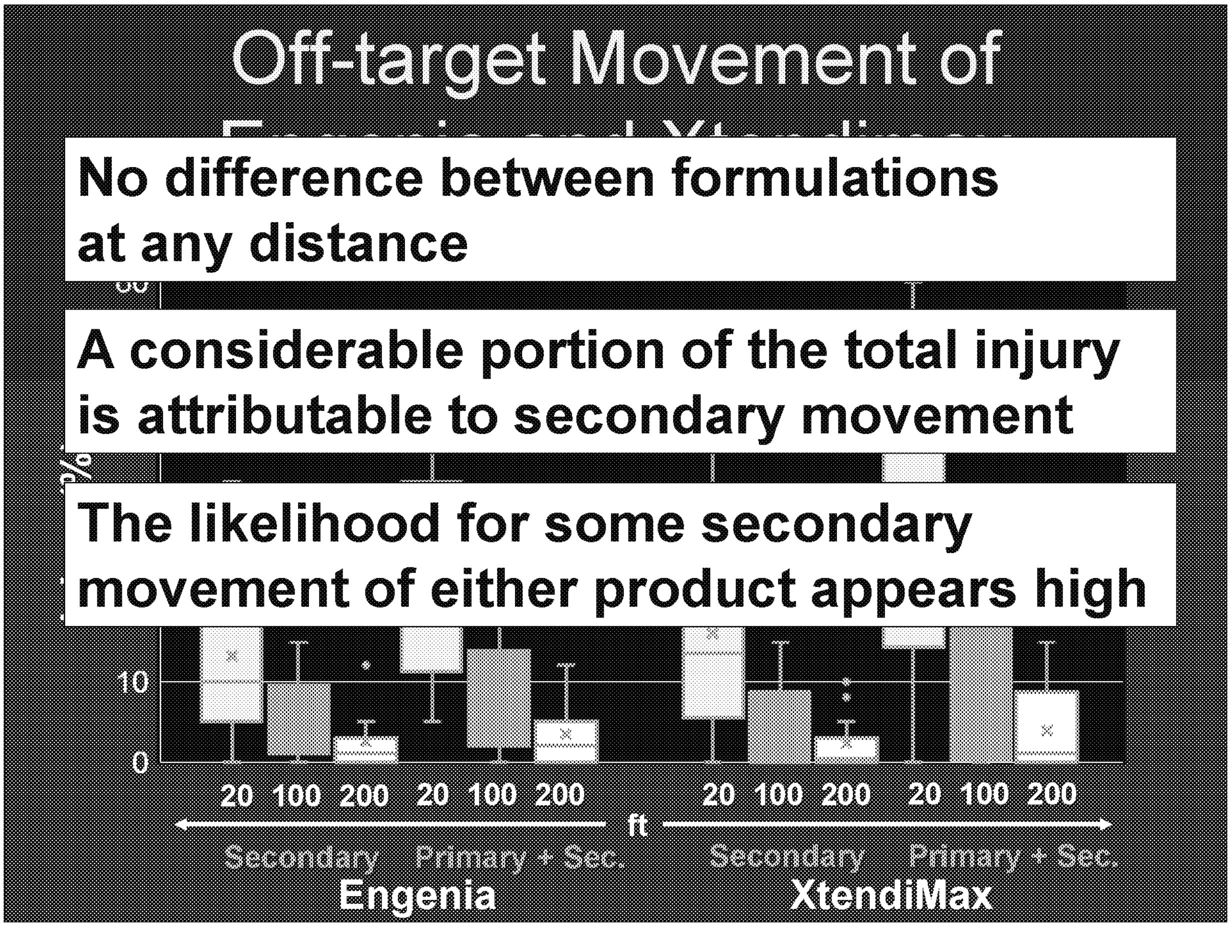


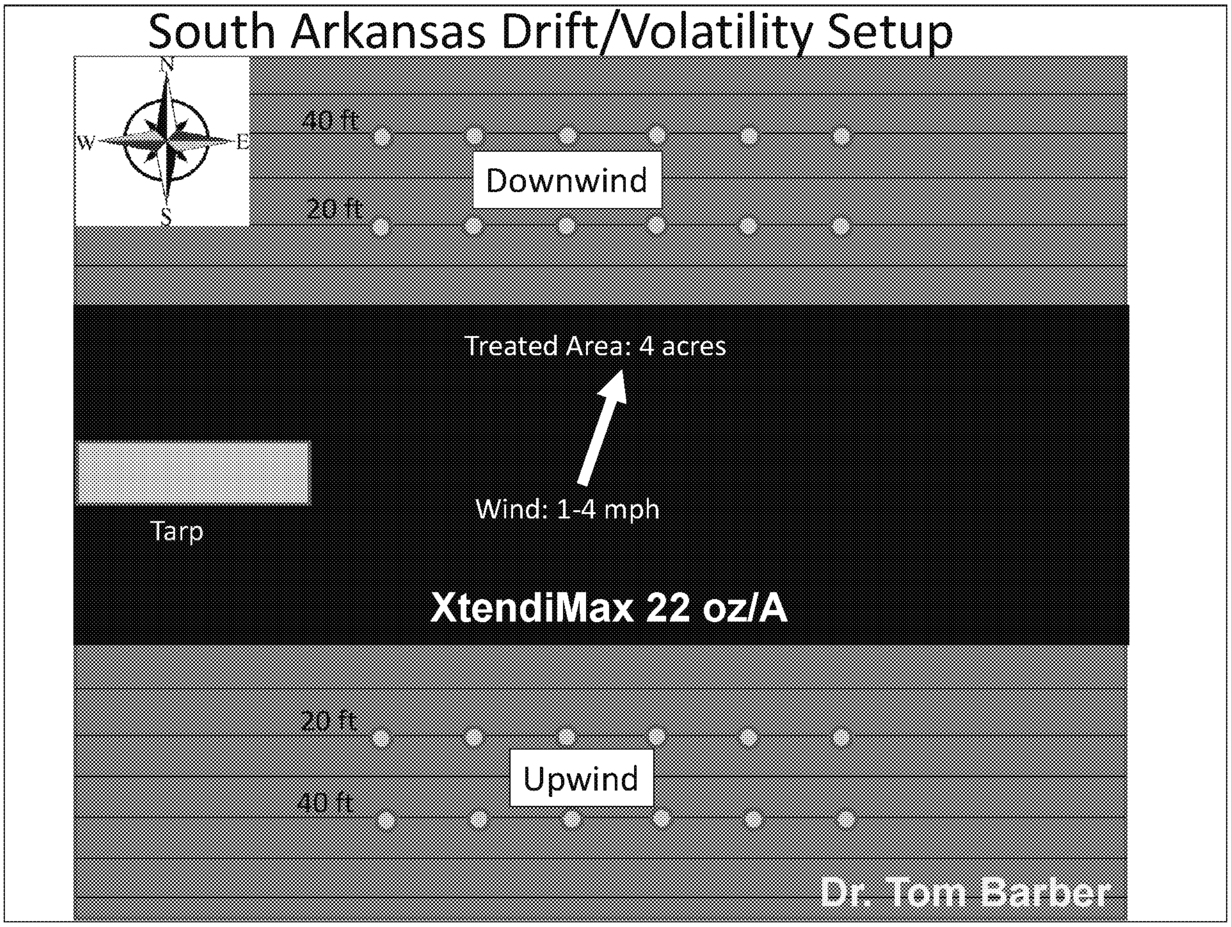
Engenia
+ Rdp Pmax



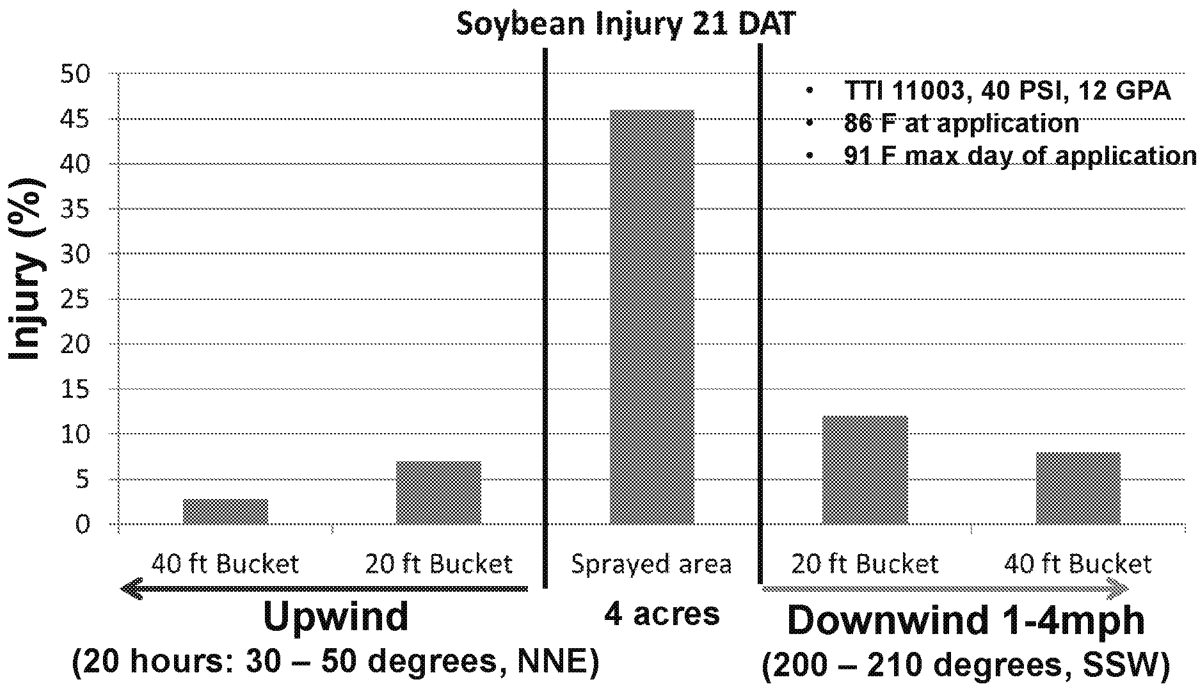
UTIA INSTITUTE OF AGRICULTURE
THE UNIVERSITY OF TENNESSEE

Dr. Larry Steckel


Off-target Movement of
No difference between formulations
at any distance
A considerable portion of the total injury
is attributable to secondary movement
The likelihood for some secondary
movement of either product appears high
10
0
20 100 200 20 100 200
20 100 200 20 100 200
ft
Secondary
Primary + Sec.
Engenia
Secondary
Primary + Sec.
XtendiMax

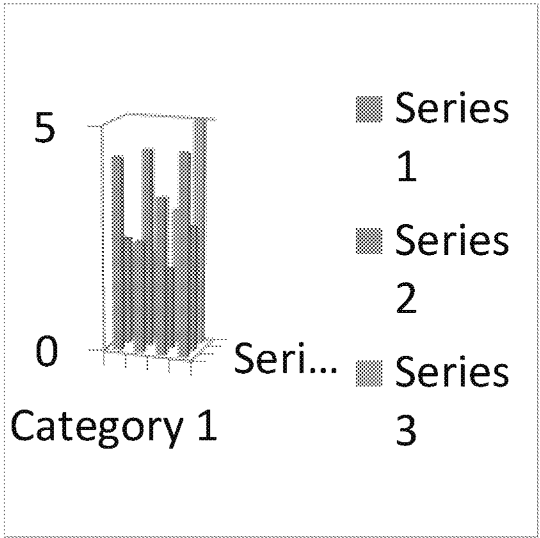

South Arkansas Drift/Volatility Setup
N
W
E
S
40 ft
20 ft
Downwind
Treated Area: 4 acres
Tarp
Wind: 1-4 mph
XtendiMax 22 oz/A
20 ft
40 ft
Upwind
Dr. Tom Barber

20-Acre Drift Study Southern Arkansas
XtendiMax 22 oz/Acre

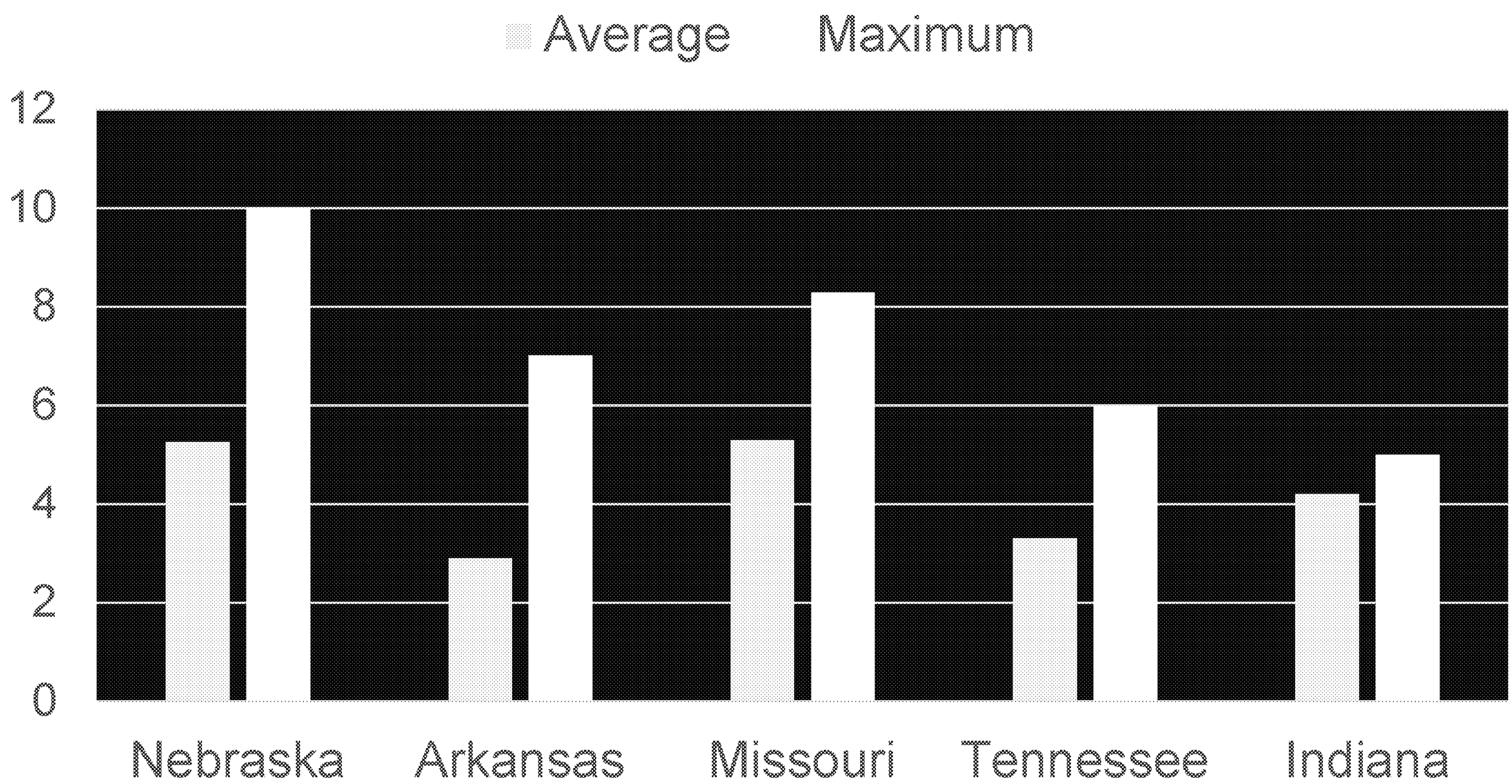


Factors Influencing Volatility

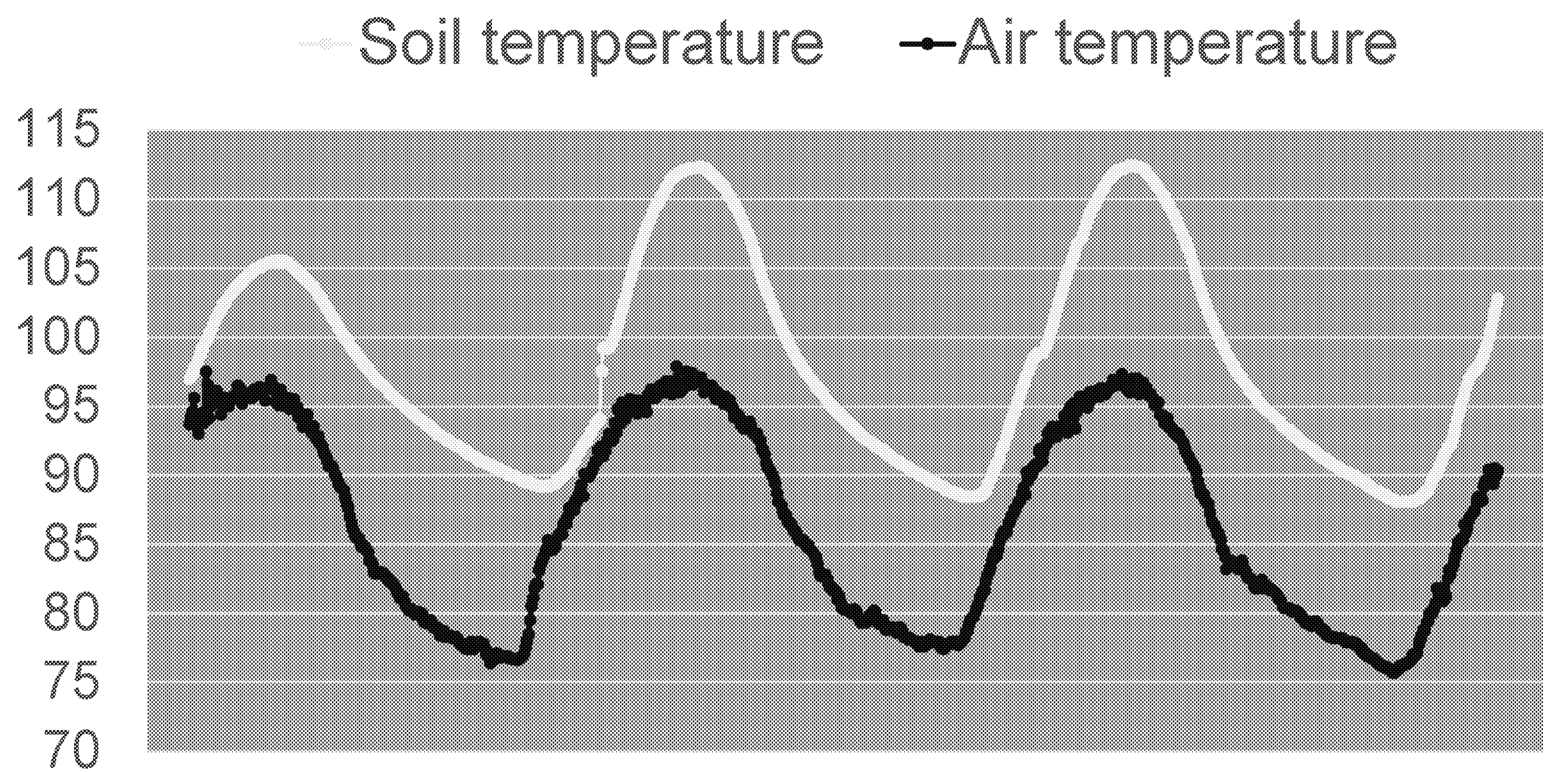
- Herbicide chemistry
- Temperature (soil & air)
- Tank-mix partner
- Vegetation or canopy formation
- Soil characteristics
- Rate
- Number of acres sprayed - *I believe this is key*


5
0
Category 1
Seri...
Series 1
Series 2
Series 3

	Series 1	Series 2	Series 3
Category 1	4.3	2.4	2
Category 2	2.5	4.4	2
Category 3	3.5	1.8	3
Category 4	4.5	2.8	5


Average
Maximum
12
10
8
6
4
2
0
Nebraska
Arkansas
Missouri
Tennessee
Indiana

	Average	Maximum
Nebraska	5.25	10
Arkansas	2.9	7
Missouri	5.3	8.3
Tennessee	3.3	6
Indiana	4.2	5


Soil temperature
Air temperature
115
110
105
100
95
90
85
80
75
70

	Soil temperature	Air temperature
7/20/2017 11:55	97	93.7
7/20/2017 12:00	97.2	94.2
7/20/2017 12:05	97.4	94.6
7/20/2017 12:10	97.7	95.6
7/20/2017 12:15	98	93.8
7/20/2017 12:20	98.2	93.5
7/20/2017 12:25	98.5	93
7/20/2017 12:30	98.8	94.2
7/20/2017 12:35	99.1	94.5
7/20/2017 12:40	99.3	93.8
7/20/2017 12:45	99.6	94.6
7/20/2017 12:50	99.8	97.5
7/20/2017 12:55	100	96.6
7/20/2017 13:00	100.3	94.1
7/20/2017 13:05	100.5	95
7/20/2017 13:10	100.8	95.4
7/20/2017 13:15	101	95.7
7/20/2017 13:20	101.2	95.9
7/20/2017 13:25	101.5	96.1
7/20/2017 13:30	101.7	95.4
7/20/2017 13:35	101.9	95.7
7/20/2017 13:40	102.1	94.4
7/20/2017 13:45	102.4	95
7/20/2017 13:50	102.5	95.2
7/20/2017 13:55	102.7	95.6
7/20/2017 14:00	102.8	95
7/20/2017 14:05	103	95
7/20/2017 14:10	103.1	95.4
7/20/2017 14:15	103.2	95.6
7/20/2017 14:20	103.4	95.7
7/20/2017 14:25	103.5	95.8
7/20/2017 14:30	103.6	95.6
7/20/2017 14:35	103.8	96.5
7/20/2017 14:40	103.9	95.7
7/20/2017 14:45	104	96.2
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7/20/2017 14:55	104.3	95.5
7/20/2017 15:00	104.4	95.8
7/20/2017 15:05	104.5	95.9
7/20/2017 15:10	104.6	95.8
7/20/2017 15:15	104.7	95.6
7/20/2017 15:20	104.8	95.6
7/20/2017 15:25	104.8	95.8
7/20/2017 15:30	104.9	96.2
7/20/2017 15:35	105	95.9
7/20/2017 15:40	105	95.9

7/20/2017 15:45	105.1	96.4
7/20/2017 15:50	105.1	96
7/20/2017 15:55	105.2	96.2
7/20/2017 16:00	105.3	96.1
7/20/2017 16:05	105.3	95.4
7/20/2017 16:10	105.4	96.2
7/20/2017 16:15	105.4	96.4
7/20/2017 16:20	105.4	96.5
7/20/2017 16:25	105.5	96.9
7/20/2017 16:30	105.5	96.5
7/20/2017 16:35	105.5	96.3
7/20/2017 16:40	105.5	95.3
7/20/2017 16:45	105.6	95.7
7/20/2017 16:50	105.6	95.1
7/20/2017 16:55	105.6	96.2
7/20/2017 17:00	105.6	95.1
7/20/2017 17:05	105.5	95.6
7/20/2017 17:10	105.5	95.1
7/20/2017 17:15	105.4	95
7/20/2017 17:20	105.4	95.6
7/20/2017 17:25	105.3	94.8
7/20/2017 17:30	105.2	94.9
7/20/2017 17:35	105.1	95.1
7/20/2017 17:40	105	95.5
7/20/2017 17:45	104.9	95
7/20/2017 17:50	104.8	94.9
7/20/2017 17:55	104.7	94.2
7/20/2017 18:00	104.6	94.2
7/20/2017 18:05	104.5	94.1
7/20/2017 18:10	104.4	93.5
7/20/2017 18:15	104.3	94.2
7/20/2017 18:20	104.2	94
7/20/2017 18:25	104.1	94.4
7/20/2017 18:30	104	93.5
7/20/2017 18:35	103.8	93.6
7/20/2017 18:40	103.7	93.1
7/20/2017 18:45	103.6	93.5
7/20/2017 18:50	103.4	92.9
7/20/2017 18:55	103.3	92.7
7/20/2017 19:00	103.1	92.8
7/20/2017 19:05	103	92.3
7/20/2017 19:10	102.8	92.2
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7/20/2017 19:35	101.9	90.7

7/20/2017 19:40	101.7	90.7
7/20/2017 19:45	101.5	90.7
7/20/2017 19:50	101.3	90.5
7/20/2017 19:55	101.2	90.1
7/20/2017 20:00	101	89.9
7/20/2017 20:05	100.8	89.5
7/20/2017 20:10	100.6	89.3
7/20/2017 20:15	100.4	89.1
7/20/2017 20:20	100.3	89
7/20/2017 20:25	100.1	88.9
7/20/2017 20:30	99.9	88.4
7/20/2017 20:35	99.8	87.9
7/20/2017 20:40	99.6	87.6
7/20/2017 20:45	99.4	87
7/20/2017 20:50	99.3	86.5
7/20/2017 20:55	99.1	86.1
7/20/2017 21:00	99	85.7
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7/20/2017 21:10	98.7	85.5
7/20/2017 21:15	98.5	85.4
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7/20/2017 21:25	98.2	84.8
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7/20/2017 21:35	97.9	84.8
7/20/2017 21:40	97.8	84.6
7/20/2017 21:45	97.7	84.4
7/20/2017 21:50	97.5	83.8
7/20/2017 21:55	97.4	83.7
7/20/2017 22:00	97.3	83.5
7/20/2017 22:05	97.1	83
7/20/2017 22:10	97	82.9
7/20/2017 22:15	96.9	82.9
7/20/2017 22:20	96.8	83
7/20/2017 22:25	96.7	83
7/20/2017 22:30	96.6	82.9
7/20/2017 22:35	96.5	82.9
7/20/2017 22:40	96.4	82.8
7/20/2017 22:45	96.3	82.6
7/20/2017 22:50	96.2	82.5
7/20/2017 22:55	96	82.3
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7/20/2017 23:05	95.8	82.2
7/20/2017 23:10	95.7	82
7/20/2017 23:15	95.6	81.9
7/20/2017 23:20	95.5	81.6
7/20/2017 23:25	95.4	81.4
7/20/2017 23:30	95.3	81.1

7/20/2017 23:35	95.2	81.2
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7/20/2017 23:45	95	80.8
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7/20/2017 23:55	94.8	80.4
7/21/2017 0:00	94.7	80.2
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7/21/2017 0:10	94.5	80.3
7/21/2017 0:15	94.5	80.1
7/21/2017 0:20	94.4	79.9
7/21/2017 0:25	94.3	80
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7/21/2017 0:45	93.9	79.9
7/21/2017 0:50	93.8	79.4
7/21/2017 0:55	93.7	79.3
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7/21/2017 1:10	93.5	79.5
7/21/2017 1:15	93.4	79.3
7/21/2017 1:20	93.3	79
7/21/2017 1:25	93.2	79
7/21/2017 1:30	93.1	79
7/21/2017 1:35	93	78.9
7/21/2017 1:40	93	78.6
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7/21/2017 2:00	92.6	78.3
7/21/2017 2:05	92.6	78.3
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7/21/2017 2:15	92.5	78.4
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7/21/2017 2:45	92.1	77.9
7/21/2017 2:50	92	77.8
7/21/2017 2:55	91.9	77.8
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7/21/2017 3:05	91.8	77.5
7/21/2017 3:10	91.7	77.4
7/21/2017 3:15	91.6	77.4
7/21/2017 3:20	91.5	77.7
7/21/2017 3:25	91.5	77.9

7/21/2017 3:30	91.4	77.8
7/21/2017 3:35	91.3	77.4
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7/21/2017 4:00	91	77.8
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7/21/2017 4:25	90.8	76.8
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7/21/2017 5:10	90.3	76.9
7/21/2017 5:15	90.3	76.9
7/21/2017 5:20	90.2	76.9
7/21/2017 5:25	90.1	76.9
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7/21/2017 5:40	90	76.7
7/21/2017 5:45	90	76.7
7/21/2017 5:50	89.9	76.7
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7/21/2017 6:00	89.8	76.6
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7/21/2017 6:25	89.5	77.5
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7/21/2017 6:35	89.5	78.5
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7/21/2017 6:50	89.3	81.1
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7/21/2017 7:00	89.3	82.1
7/21/2017 7:05	89.2	82.1
7/21/2017 7:10	89.2	83.1
7/21/2017 7:15	89.2	83.6
7/21/2017 7:20	89.2	83.8

7/21/2017 7:25	89.2	84.1
7/21/2017 7:30	89.2	84.4
7/21/2017 7:35	89.2	84.7
7/21/2017 7:40	89.2	85.3
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7/21/2017 8:10	89.6	85.5
7/21/2017 8:15	89.7	85.7
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7/21/2017 8:30	90	86.4
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7/21/2017 8:45	90.4	87
7/21/2017 8:50	90.5	87.6
7/21/2017 8:55	90.7	87.6
7/21/2017 9:00	90.9	87.8
7/21/2017 9:05	91	87.5
7/21/2017 9:10	91.2	88.2
7/21/2017 9:15	91.5	88.1
7/21/2017 9:20	91.7	88.6
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7/21/2017 9:35	92.2	88.5
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7/21/2017 9:45	92.5	89.9
7/21/2017 9:50	92.7	90
7/21/2017 9:55	92.9	89.9
7/21/2017 10:00	93.1	90.3
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7/21/2017 10:10	93.5	90.7
7/21/2017 10:15	93.7	91
7/21/2017 10:20	93.8	91
7/21/2017 10:25	94	91.8
7/21/2017 10:30	94.1	91.6
7/21/2017 10:35	97.6	92.1
7/21/2017 10:40	99.2	91.4
7/21/2017 10:45	99.3	92
7/21/2017 10:50	99.2	91.8
7/21/2017 10:55	99.2	92.5
7/21/2017 11:00	99.3	93
7/21/2017 11:05	99.5	92.9
7/21/2017 11:10	99.7	92.5
7/21/2017 11:15	100	92.6

7/21/2017 11:20	100.3	93.8
7/21/2017 11:25	100.6	93.1
7/21/2017 11:30	101	94.8
7/21/2017 11:35	101.4	94.6
7/21/2017 11:40	101.8	93.8
7/21/2017 11:45	102.2	95.3
7/21/2017 11:50	102.6	95
7/21/2017 11:55	103	94.1
7/21/2017 12:00	103.4	95
7/21/2017 12:05	103.9	94.5
7/21/2017 12:10	104.2	95.5
7/21/2017 12:15	104.6	94.9
7/21/2017 12:20	105	95.2
7/21/2017 12:25	105.4	95.1
7/21/2017 12:30	105.8	95.4
7/21/2017 12:35	106.1	94.5
7/21/2017 12:40	106.4	95
7/21/2017 12:45	106.7	95.3
7/21/2017 12:50	107.1	94.9
7/21/2017 12:55	107.4	95.4
7/21/2017 13:00	107.7	95.1
7/21/2017 13:05	108	94.6
7/21/2017 13:10	108.3	95.9
7/21/2017 13:15	108.5	95.8
7/21/2017 13:20	108.8	96.2
7/21/2017 13:25	109.1	95.6
7/21/2017 13:30	109.3	96.2
7/21/2017 13:35	109.5	95.6
7/21/2017 13:40	109.7	95.8
7/21/2017 13:45	109.9	96.2
7/21/2017 13:50	110.1	96.5
7/21/2017 13:55	110.3	96.2
7/21/2017 14:00	110.5	96.3
7/21/2017 14:05	110.7	96
7/21/2017 14:10	110.9	96.8
7/21/2017 14:15	111.1	96.3
7/21/2017 14:20	111.3	96.2
7/21/2017 14:25	111.4	96.8
7/21/2017 14:30	111.5	95.9
7/21/2017 14:35	111.7	96.6
7/21/2017 14:40	111.8	96.6
7/21/2017 14:45	111.8	97.9
7/21/2017 14:50	111.9	96.4
7/21/2017 14:55	112	96
7/21/2017 15:00	112	96.7
7/21/2017 15:05	112.1	96.3
7/21/2017 15:10	112.1	96.5

7/21/2017 15:15	112.2	97.5
7/21/2017 15:20	112.2	96.9
7/21/2017 15:25	112.2	96.6
7/21/2017 15:30	112.3	97.1
7/21/2017 15:35	112.3	97.4
7/21/2017 15:40	112.3	96.6
7/21/2017 15:45	112.3	97.2
7/21/2017 15:50	112.3	96.8
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7/21/2017 16:00	112.4	96.7
7/21/2017 16:05	112.3	97.1
7/21/2017 16:10	112.3	96.7
7/21/2017 16:15	112.3	96
7/21/2017 16:20	112.2	96.3
7/21/2017 16:25	112.1	96.5
7/21/2017 16:30	112	96.2
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7/21/2017 16:55	111.5	95.5
7/21/2017 17:00	111.4	96
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7/21/2017 17:10	111.1	95.7
7/21/2017 17:15	111	95.5
7/21/2017 17:20	110.9	95.2
7/21/2017 17:25	110.7	95.7
7/21/2017 17:30	110.5	95.2
7/21/2017 17:35	110.3	95.1
7/21/2017 17:40	110.1	95.4
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7/21/2017 17:50	109.8	94.8
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7/21/2017 18:00	109.4	94.3
7/21/2017 18:05	109.2	94.4
7/21/2017 18:10	109	94.3
7/21/2017 18:15	108.7	93.7
7/21/2017 18:20	108.5	93.9
7/21/2017 18:25	108.2	93.4
7/21/2017 18:30	108	93.5
7/21/2017 18:35	107.7	93.5
7/21/2017 18:40	107.5	93.8
7/21/2017 18:45	107.2	93.9
7/21/2017 18:50	106.9	93.6
7/21/2017 18:55	106.5	93.1
7/21/2017 19:00	106.2	93
7/21/2017 19:05	105.8	92.9

7/21/2017 19:10	105.4	93
7/21/2017 19:15	105	92.6
7/21/2017 19:20	104.7	92.5
7/21/2017 19:25	104.3	92
7/21/2017 19:30	104	91.8
7/21/2017 19:35	103.7	91.5
7/21/2017 19:40	103.4	90.9
7/21/2017 19:45	103.1	90.6
7/21/2017 19:50	102.8	90.4
7/21/2017 19:55	102.5	90.2
7/21/2017 20:00	102.3	90
7/21/2017 20:05	102	89.7
7/21/2017 20:10	101.7	89.4
7/21/2017 20:15	101.4	88.7
7/21/2017 20:20	101.2	88.1
7/21/2017 20:25	100.9	88
7/21/2017 20:30	100.7	87.8
7/21/2017 20:35	100.4	87.4
7/21/2017 20:40	100.2	87.1
7/21/2017 20:45	100	87.1
7/21/2017 20:50	99.7	86.7
7/21/2017 20:55	99.5	86.5
7/21/2017 21:00	99.3	86.5
7/21/2017 21:05	99.1	86.3
7/21/2017 21:10	98.9	86
7/21/2017 21:15	98.7	86
7/21/2017 21:20	98.5	85.8
7/21/2017 21:25	98.3	85.5
7/21/2017 21:30	98.1	85.3
7/21/2017 21:35	98	85.3
7/21/2017 21:40	97.8	85.3
7/21/2017 21:45	97.6	85.1
7/21/2017 21:50	97.4	85
7/21/2017 21:55	97.3	84.8
7/21/2017 22:00	97.1	84.9
7/21/2017 22:05	97	84.6
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7/21/2017 22:15	96.8	84.4
7/21/2017 22:20	96.6	84.2
7/21/2017 22:25	96.5	84
7/21/2017 22:30	96.3	83.6
7/21/2017 22:35	96.2	83
7/21/2017 22:40	96.1	82.7
7/21/2017 22:45	95.9	82.7
7/21/2017 22:50	95.8	82.7
7/21/2017 22:55	95.6	82.8
7/21/2017 23:00	95.5	82.5

7/21/2017 23:05	95.3	82.2
7/21/2017 23:10	95.2	81.9
7/21/2017 23:15	95.1	81.9
7/21/2017 23:20	94.9	81.7
7/21/2017 23:25	94.8	81.7
7/21/2017 23:30	94.7	81.6
7/21/2017 23:35	94.6	81
7/21/2017 23:40	94.5	81.2
7/21/2017 23:45	94.4	80.8
7/21/2017 23:50	94.2	80.4
7/21/2017 23:55	94.1	80.3
7/22/2017 0:00	94	80.3
7/22/2017 0:05	93.9	80.3
7/22/2017 0:10	93.8	80.2
7/22/2017 0:15	93.7	80.2
7/22/2017 0:20	93.6	80
7/22/2017 0:25	93.5	80
7/22/2017 0:30	93.4	80.3
7/22/2017 0:35	93.3	80.2
7/22/2017 0:40	93.2	79.9
7/22/2017 0:45	93.1	79.7
7/22/2017 0:50	93	79.5
7/22/2017 0:55	92.9	79.3
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7/22/2017 1:05	92.7	79.4
7/22/2017 1:10	92.6	79.3
7/22/2017 1:15	92.5	79.6
7/22/2017 1:20	92.5	79.8
7/22/2017 1:25	92.4	79.7
7/22/2017 1:30	92.3	80
7/22/2017 1:35	92.2	80.2
7/22/2017 1:40	92.2	80.1
7/22/2017 1:45	92.1	79.6
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7/22/2017 2:15	91.6	78.8
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7/22/2017 2:35	91.3	79
7/22/2017 2:40	91.2	78.9
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7/22/2017 2:55	91	78.7

7/22/2017 3:00	90.9	79
7/22/2017 3:05	90.9	78.9
7/22/2017 3:10	90.8	78.6
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7/22/2017 3:55	90.2	77.9
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7/22/2017 4:15	90	77.8
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7/22/2017 4:25	89.8	77.8
7/22/2017 4:30	89.8	77.8
7/22/2017 4:35	89.7	77.9
7/22/2017 4:40	89.6	78.1
7/22/2017 4:45	89.6	78
7/22/2017 4:50	89.5	77.9
7/22/2017 4:55	89.5	77.9
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7/22/2017 5:25	89.1	77.4
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7/22/2017 5:35	89	77.8
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7/22/2017 12:15	104.8	93.1
7/22/2017 12:20	105.1	94.7
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7/22/2017 12:30	105.7	94.9
7/22/2017 12:35	106	95.2
7/22/2017 12:40	106.4	93.4
7/22/2017 12:45	106.8	94.6
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7/22/2017 12:55	107	95.7
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7/22/2017 13:10	107.8	95
7/22/2017 13:15	108.2	95.3
7/22/2017 13:20	108.5	94.9
7/22/2017 13:25	108.8	95.3
7/22/2017 13:30	109.1	96
7/22/2017 13:35	109.3	95.6
7/22/2017 13:40	109.5	95.8
7/22/2017 13:45	109.7	95.7
7/22/2017 13:50	109.9	96.1
7/22/2017 13:55	110.1	95.8
7/22/2017 14:00	110.4	95.7
7/22/2017 14:05	110.5	96.3
7/22/2017 14:10	110.7	96
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7/22/2017 14:20	111.1	95.9
7/22/2017 14:25	111.3	96.3
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7/22/2017 14:35	111.5	96.3
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7/22/2017 15:10	112.2	96.7
7/22/2017 15:15	112.2	97.3
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7/22/2017 15:25	112.3	96.4
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7/22/2017 16:25	112.2	96.7
7/22/2017 16:30	112.1	96.4
7/22/2017 16:35	111.9	96.3
7/22/2017 16:40	111.8	95.9
7/22/2017 16:45	111.7	95.8
7/22/2017 16:50	111.6	95.9
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7/22/2017 17:25	110.5	94.3
7/22/2017 17:30	110.3	94.3
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7/22/2017 18:30	107.7	92.6
7/22/2017 18:35	107.4	92.4

7/22/2017 18:40	107.2	92.1
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7/22/2017 20:10	101.3	86.7
7/22/2017 20:15	101	86.5
7/22/2017 20:20	100.7	86.4
7/22/2017 20:25	100.5	86.1
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7/22/2017 20:55	99	84.1
7/22/2017 21:00	98.8	83.2
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7/22/2017 21:30	97.6	83.4
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7/22/2017 22:25	96	82.4
7/22/2017 22:30	95.8	82

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7/23/2017 3:55	90	77.9
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7/23/2017 4:40	89.4	77.1
7/23/2017 4:45	89.3	76.9
7/23/2017 4:50	89.2	76.9
7/23/2017 4:55	89.2	76.8
7/23/2017 5:00	89.1	76.7
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7/23/2017 5:35	88.6	76.2
7/23/2017 5:40	88.6	76.1
7/23/2017 5:45	88.5	76.1
7/23/2017 5:50	88.5	76
7/23/2017 5:55	88.4	76
7/23/2017 6:00	88.3	75.9
7/23/2017 6:05	88.3	75.9
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7/23/2017 6:20	88.1	75.8

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7/23/2017 6:30	88.1	76.1
7/23/2017 6:35	88.1	76.2
7/23/2017 6:40	88.1	76.2
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7/23/2017 7:20	88.2	77
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7/23/2017 7:30	88.3	77.2
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7/23/2017 8:00	88.9	79.3
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7/23/2017 8:55	91.4	80.9
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7/23/2017 9:05	91.8	81.2
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7/23/2017 11:05	98.6	88.2
7/23/2017 11:10	98.9	89.2
7/23/2017 11:15	99.2	89.6
7/23/2017 11:20	99.5	89.4
7/23/2017 11:25	99.9	90.4
7/23/2017 11:30	100.4	90.2
7/23/2017 11:35	100.9	90.2
7/23/2017 11:40	101.4	89.4
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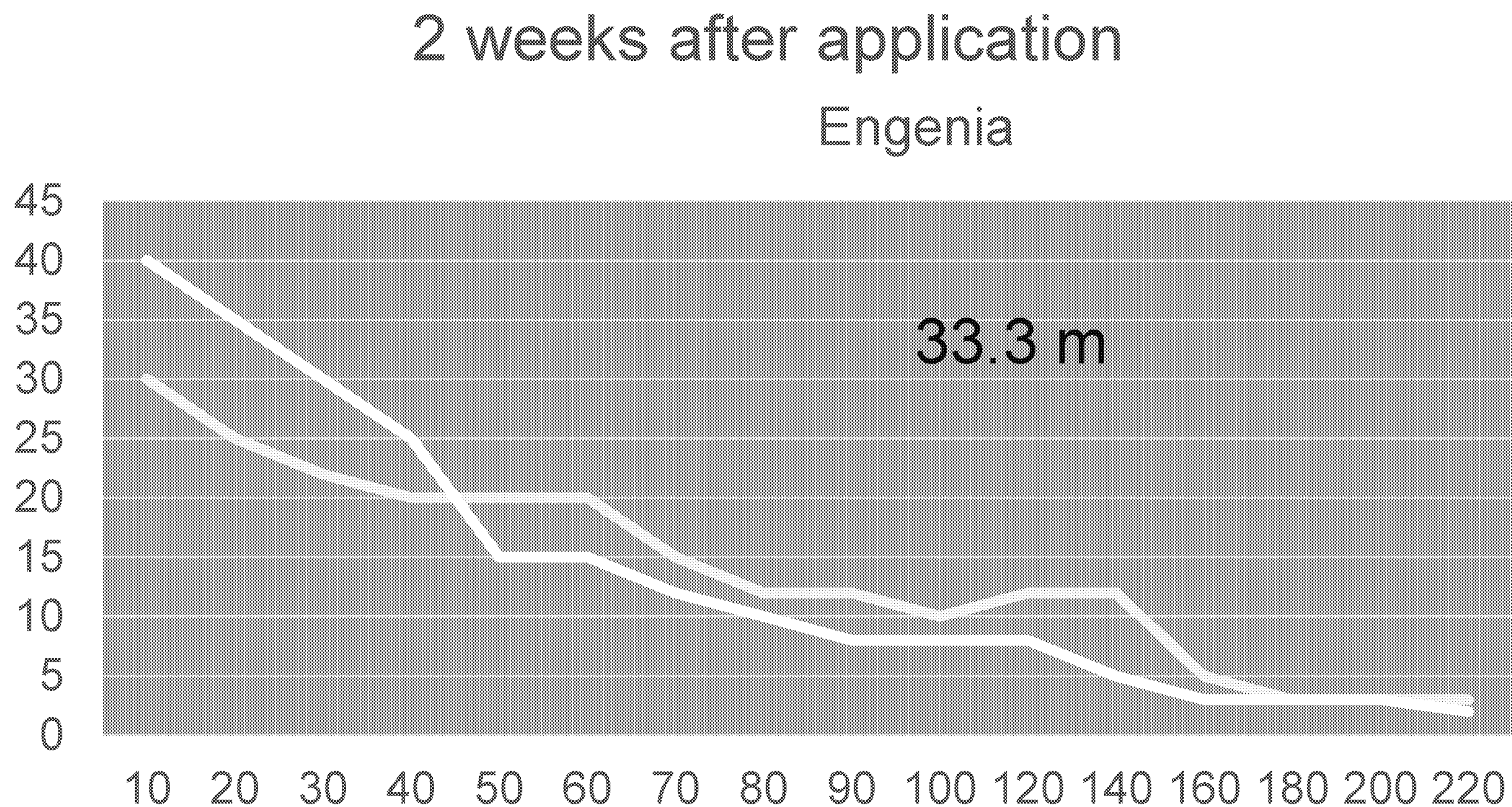
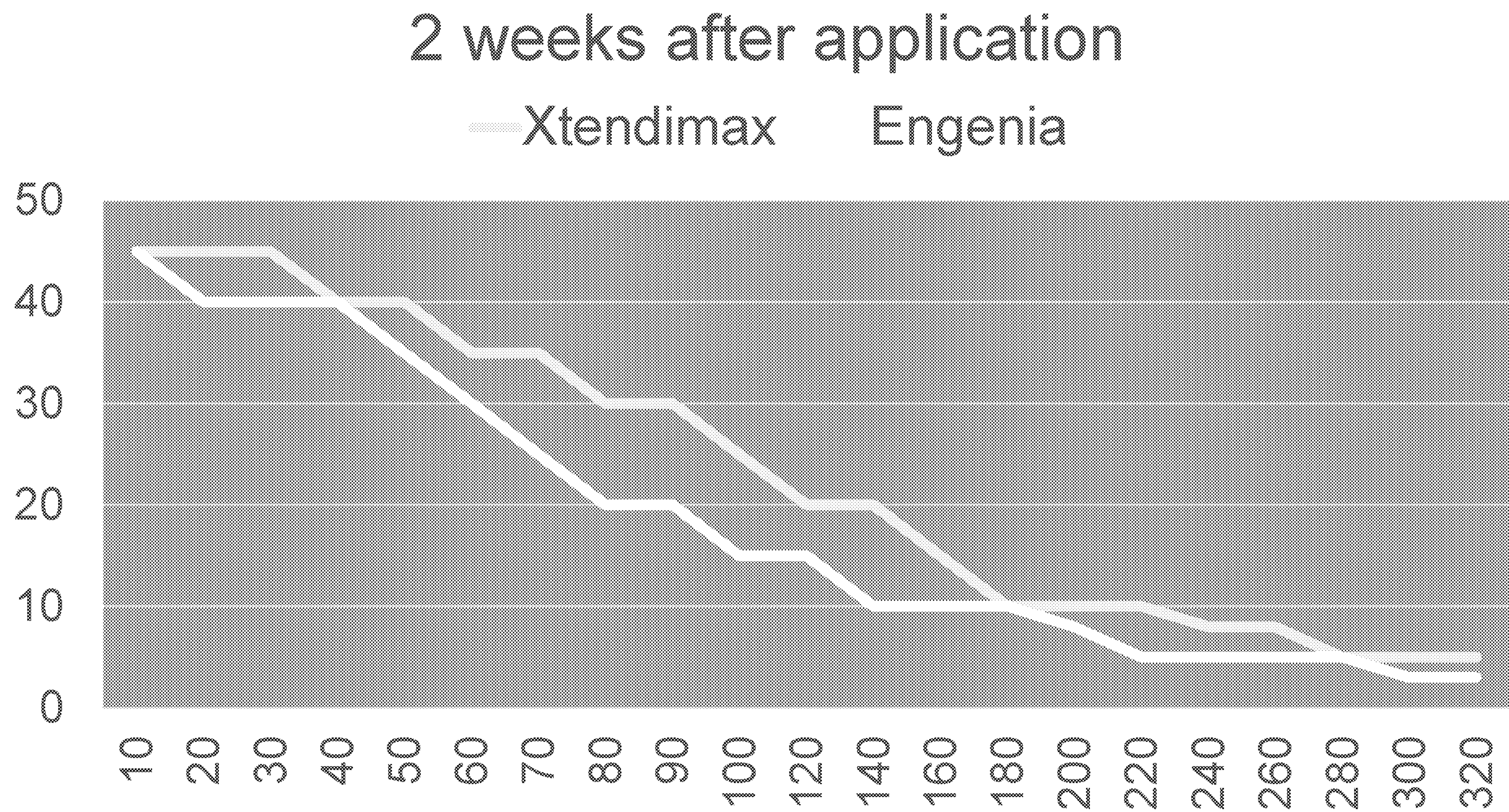
7/23/2017 11:55	102.8	90.3

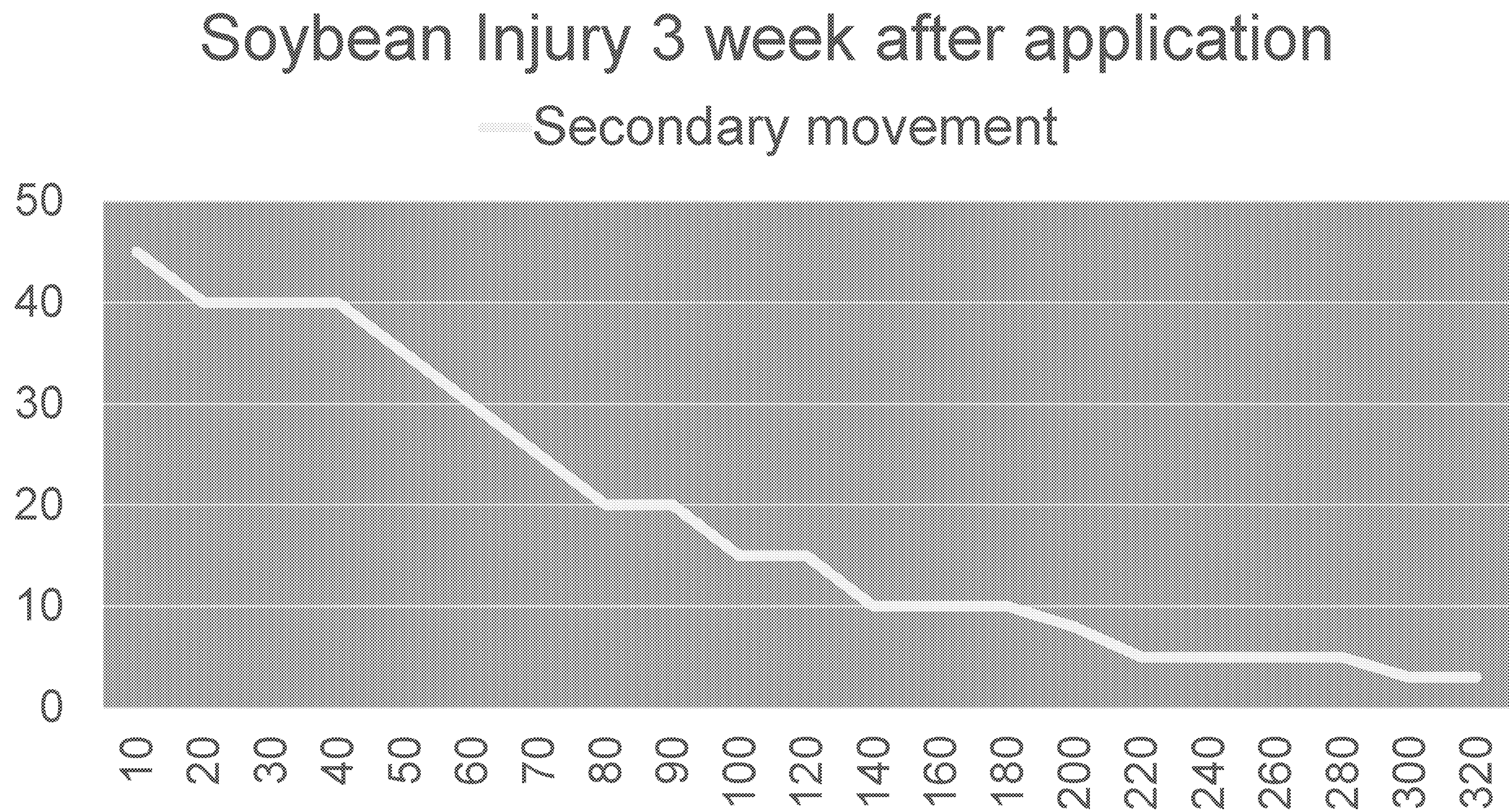

2 weeks after application
Engenia
33.3 m
45
40
35
30
25
20
15
10
5
0
10 20 30 40 50 60 70 80 90 100 120 140 160 180 200 220

	Xtendimax	Engenia
10	30	40
20	25	35
30	22	30
40	20	25
50	20	15
60	20	15
70	15	12
80	12	10
90	12	8
100	10	8
120	12	8
140	12	5
160	5	3
180	3	3
200	3	3
220	3	2

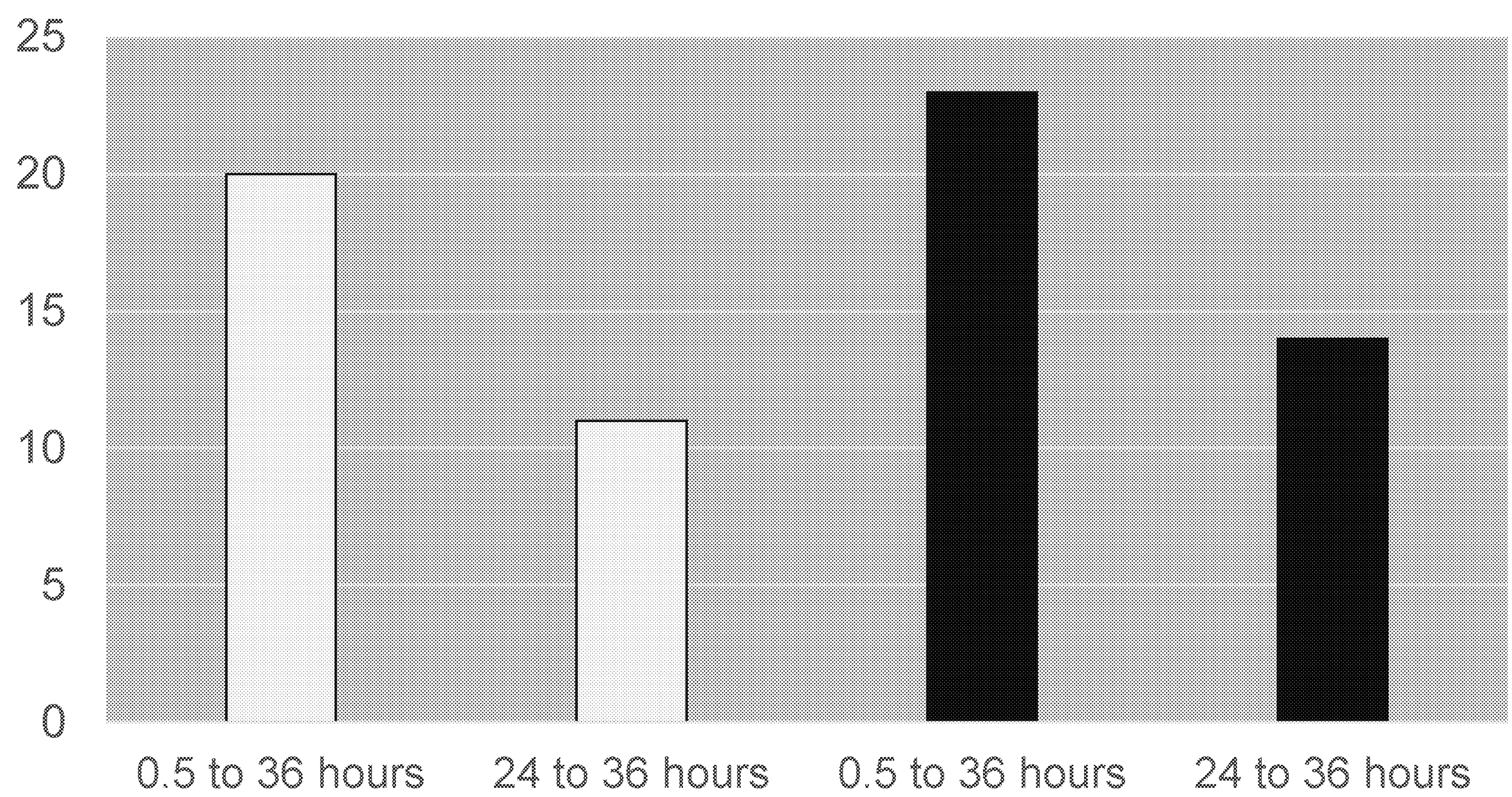


2 weeks after application
Xtendimax
Engenia
50
40
30
20
10
0
10
20
30
40
50
60
70
80
90
100
120
140
160
180
200
220
240
260
280
300
320

	Xtendimax	Engenia
10	45	45
20	45	40
30	45	40
40	40	40
50	40	35
60	35	30
70	35	25
80	30	20
90	30	20
100	25	15
120	20	15
140	20	10
160	15	10
180	10	10
200	10	8
220	10	5
240	8	5
260	8	5
280	5	5
300	5	3
320	5	3

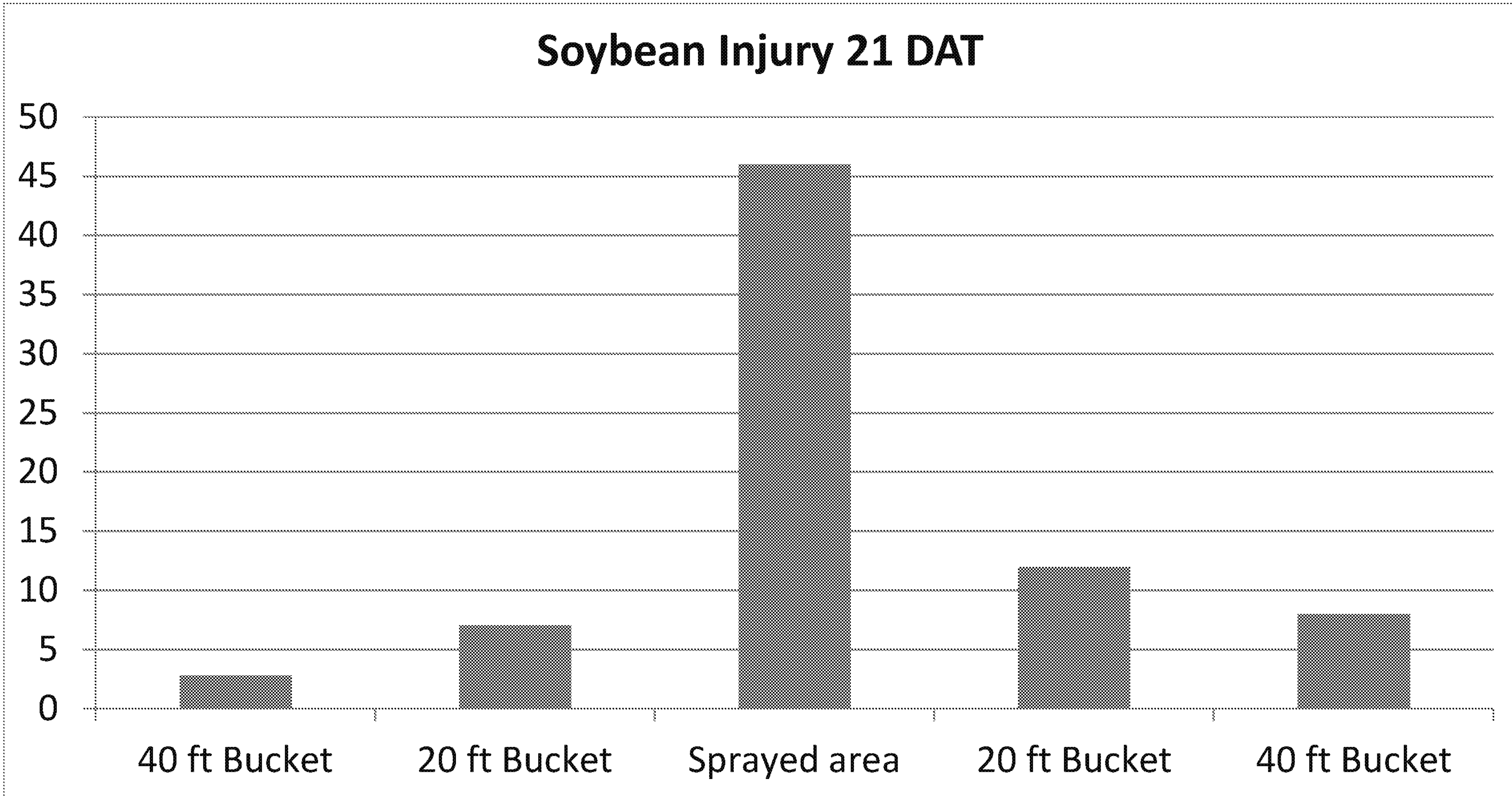

Soybean Injury 3 week after application
Secondary movement
50
40
30
20
10
0
10
20
30
40
50
60
70
80
90
100
120
140
160
180
200
220
240
260
280
300
320

	Secondary movement
10	45
20	40
30	40
40	40
50	35
60	30
70	25
80	20
90	20
100	15
120	15
140	10
160	10
180	10
200	8
220	5
240	5
260	5
280	5
300	3
320	3



25
20
15
10
5
0
0.5 to 36 hours
24 to 36 hours
0.5 to 36 hours
24 to 36 hours

	Column1
0.5 to 36 hours	20
24 to 36 hours	11
0.5 to 36 hours	23
24 to 36 hours	14



Soybean Injury 21 DAT
50
45
40
35
30
25
20
15
10
5
0
40 ft Bucket
20 ft Bucket
Sprayed area
20 ft Bucket
40 ft Bucket

	Soybean Injury	Series 2	Series 3
40 ft Bucket	2.8	2.4	2
20 ft Bucket	7	1.8	3
Sprayed area	46		
20 ft Bucket	12		
40 ft Bucket	8		

20.83333333 37.08333333 7.083333333 21.25

Message

From: Kenny, Daniel [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=1BE9BB592F144269BCD41DD3A6D8A6D4-DANIEL C. KENNY]
Sent: 3/20/2018 2:31:34 PM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
Subject: RE: WSSA presentation

Thanks Jason!

Daniel Kenny, Chief
Herbicide Branch
Registration Division
Office of Pesticide Programs
U.S. Environmental Protection Agency

From: Jason Keith Norsworthy [mailto:jnorswor@uark.edu]
Sent: Tuesday, March 20, 2018 10:22 AM
To: Kenny, Daniel <Kenny.Dan@epa.gov>
Subject: WSSA presentation

Here is the presentation. Let me know if you have questions.

Jason Norsworthy, PhD
Professor and Elms Farming Chair of Weed Science
1366 West Altheimer Dr.
Fayetteville, AR 72704
Tel: 479-575-8740
Mob: 479-313-1265

Message

From: Kenny, Daniel [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=1BE9BB592F144269BCD41DD3A6D8A6D4-DANIEL C. KENNY]
Sent: 9/11/2018 2:28:07 AM
To: Rosenblatt, Daniel [Rosenblatt.Dan@epa.gov]
CC: jnorswor@uark.edu
Subject: Re: formulation info

Thanks Jason, this is very much appreciated! We'll take a look and then follow up with you. In the meantime, I hope all is well with you.

Thanks again,
Dan

Sent from my iPhone

On Sep 10, 2018, at 5:47 PM, Rosenblatt, Daniel <Rosenblatt.Dan@epa.gov> wrote:

> Jason – do you happen to have formulation specific data on dicamba flux in any of your trials that you could send to EPA? I am especially interested in information on the new formulations. Thanks for looking into this.
>
> Dan
>
> Daniel J. Rosenblatt, Deputy Director,
> Registration Division, Office of Pesticide Programs
> Rosenblatt.dan@epa.gov
> 703-308-9366

Message

From: Scott Senseman (via Google Docs) [ssensema@gmail.com]
Sent: 5/30/2018 8:51:04 PM
To: Peck, Charles [Peck.Charles@epa.gov]
CC: chad.asmus@basf.com; marathonag@zianet.com; Baris, Reuben [Baris.Reuben@epa.gov]; Bradleyke@missouri.edu; jbunting@growmark.com; arlene.cotie@bayer.com; stanley@uga.edu; rgrant@purdue.edu; hager@illinois.edu; a.hewitt@uq.edu.au; Keigwin, Richard [Keigwin.Richard@epa.gov]; Kenny, Daniel [Kenny.Dan@epa.gov]; gkruger2@unl.edu; BNichols@cottoninc.com; jnorswor@uark.edu; jeanp@ifca.com; jreiss@precisionlab.com; dreynolds@pss.msstate.edu; ssensema@utk.edu; ssmith@redgold.com; lsteckel@utk.edu; hthistle@fs.fed.us; Lee.VanWychen@wssa.net; Jweirich@mfa-inc.com; Sid Abel [Sidney.W.Abel@aphis.usda.gov]
Subject: Dicamba Report_May 30.docx - Invitation to comment

Scott Senseman has invited you to **comment on** the following document:

Dicamba Report_May 30.docx

Open in Docs

Message

Sent: 10/19/2018 4:17:40 PM
To: Jason Keith Norsworthy [jnorswor@uark.edu]
Subject: RE: Question Regarding 2017 Field Small Field Study

Great! Thank you very much and have a great weekend!

Chuck Peck
OPP/EFED/ERB VI
Potomac Yard South
Crystal City, VA
Room 10244
(703) 347-8064
peck.charles@epa.gov

From: Jason Keith Norsworthy [mailto:jnorswor@uark.edu]
Sent: Friday, October 19, 2018 12:14 PM
To: Peck, Charles <Peck.Charles@epa.gov>
Subject: RE: Question Regarding 2017 Field Small Field Study

I believe there were 10 plants from each location.

From: Peck, Charles <Peck.Charles@epa.gov>
Sent: Friday, October 19, 2018 8:58 AM
To: Jason Keith Norsworthy <jnorswor@uark.edu>
Cc: Corbin, Mark <Corbin.Mark@epa.gov>; Odenkirchen, Edward <Odenkirchen.Edward@epa.gov>; Baris, Reuben <Baris.Reuben@epa.gov>
Subject: Question Regarding 2017 Field Small Field Study

Hi Dr. Norsworthy,

I have a question regarding the spreadsheet you sent pertaining to the 2017 small field studies that were done in NE, AR. TN, MO, and IN. In the spreadsheet you provided plant height and visual injury measurements for the AR (08-14 volatility – North worksheet). Do you know the number of plants sampled at each distance to develop the visual injury and plant height estimates at the different distances along the transects?

As always, thank you very much for your help with this!

Chuck Peck
OPP/EFED/ERB VI
Potomac Yard South
Crystal City, VA
Room 10244
(703) 347-8064
peck.charles@epa.gov

Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 10/19/2018 4:13:58 PM
To: Peck, Charles [Peck.Charles@epa.gov]
Subject: RE: Question Regarding 2017 Field Small Field Study

I believe there were 10 plants from each location.

From: Peck, Charles <Peck.Charles@epa.gov>
Sent: Friday, October 19, 2018 8:58 AM
To: Jason Keith Norsworthy <jnorswor@uark.edu>
Cc: Corbin, Mark <Corbin.Mark@epa.gov>; Odenkirchen, Edward <Odenkirchen.Edward@epa.gov>; Baris, Reuben <Baris.Reuben@epa.gov>
Subject: Question Regarding 2017 Field Small Field Study

Hi Dr. Norsworthy,

I have a question regarding the spreadsheet you sent pertaining to the 2017 small field studies that were done in NE, AR. TN, MO, and IN. In the spreadsheet you provided plant height and visual injury measurements for the AR (08-14 volatility – North worksheet). Do you know the number of plants sampled at each distance to develop the visual injury and plant height estimates at the different distances along the transects?

As always, thank you very much for your help with this!

Chuck Peck
OPP/EFED/ERB VI
Potomac Yard South
Crystal City, VA
Room 10244
(703) 347-8064
peck.charles@epa.gov

Message

From: Jason Keith Norsworthy [jnorswor@uark.edu]
Sent: 10/23/2018 11:42:28 AM
To: Peck, Charles [Peck.Charles@epa.gov]
Subject: RE: Questions on Trials Presented in AR State Board Presentation

See below responses.

From: Peck, Charles <Peck.Charles@epa.gov>
Sent: Tuesday, October 23, 2018 6:34 AM
To: Jason Keith Norsworthy <jnorswor@uark.edu>
Cc: Corbin, Mark <Corbin.Mark@epa.gov>; Odenkirchen, Edward <Odenkirchen.Edward@epa.gov>; Baris, Reuben <Baris.Reuben@epa.gov>
Subject: Questions on Trials Presented in AR State Board Presentation

Hi Dr. Norsworthy,

I had some questions regarding the information provided in your 2018 presentation to the Arkansas State Board on Sep 20, 2018.

Slides 56-67 discuss the tunnel volatility studies that you conducted

1. On slide 56, the date is September 18, 2018. Is this the date when the trials were conducted, or just the date of the photo? If it reflects when the trials were conducted, I don't understand how the analysis could have been performed and then presented on Sep 20th?
   September 18 was the date the photo was taken that shows how the tunnels appear in the field. The data presented were from earlier studies in the summer.

2. What were the application rates for the trials? Was it the standard 0.5 lb ae/A for dicamba products and 1 lb ae/A for glyphosate products?
   A 4X rate of herbicide is used in the low tunnel volatility studies because we only treat two flats of soil that are 12 by 18 inches. These trays are removed from the tunnels 48 hours after introduction into the tunnel.
3. On slide 60, there is a comparison of Engenia with and without Roundup, but none with Xtendimax without Roundup. Did you conduct any trials with just Xtendimax alone?
   I have a trial with and without Xtendimax that was initiated 4 weeks ago. I rated it yesterday and saw a similar effect. I also have the large plot drift trial that was conducted at Keiser comparing Xtendimax + Roundup to an application without Xtendimax. In addition to the data shown in the slides, there was less injury to covered plants when glyphosate was removed from Xtendimax.
4. On slide 69, there is a comparison of the pH values for different tank mix solutions. Were these part of the tunnel volatility study, or something different? These were part of a tunnel volatility study that was initiated late in the year. I was only showing here that glyphosate further lowers the pH of Xtendimax, which may contribute to the increased volatility.

As always, thank you very much for your help!

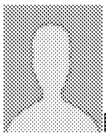
Chuck Peck
OPP/EFED/ERB VI
Potomac Yard South
Crystal City, VA
Room 10244
(703) 347-8064
peck.charles@epa.gov

Message

From: Scott Senseman (via Google Docs) [ssensema@gmail.com]
Sent: 5/30/2018 8:43:37 PM
To: Peck, Charles [Peck.Charles@epa.gov]
CC: Sid Abel [Sidney.W.Abel@aphis.usda.gov]; chad.asmus@basf.com; marathonag@zianet.com; Baris, Reuben [Baris.Reuben@epa.gov]; Bradleyke@missouri.edu; jbunting@growmark.com; arlene.cotie@bayer.com; stanley@uga.edu; jferrell@ufl.edu; rgrant@purdue.edu; hager@illinois.edu; a.hewitt@uq.edu.au; Kenny, Daniel [Kenny.Dan@epa.gov]; gkruger2@unl.edu; rleon@ncsu.edu; BNichols@cottoninc.com; jnorswor@uark.edu; jeanp@ifca.com; jreiss@precisionlab.com; dreynolds@pss.msstate.edu; ssensema@utk.edu; DShaw@research.msstate.edu; wgs@turbodrop.com; ssmith@redgold.com; lsteckel@utk.edu; hthistle@fs.fed.us; Lee.VanWychen@wssa.net; Jweirich@mfa-inc.com; Keigwin, Richard [Keigwin.Richard@epa.gov]
Subject: Dicamba Report_May 30.docx - Invitation to edit

Scott Senseman has invited you to **edit** the following document:

Dicamba Report_May 30.docx


Dear Invitees and Participants,

Once again, I would like to thank all of you for being willing to participate in our April workshop in DC to discuss herbicide off-target movement. I believe that it was a very productive meeting and we hope to have a set of positive outcomes going forward. Our writing committee has done a great deal of work to capture the points made at the meeting and to provide a comprehensive report for your review. We very much would like to keep the review process short and to get feedback from this group in the next 7 days (by June 6, 2018 Close of Business). Upon that deadline, we will be sending it to two WSSA Committees, 1) Formulations, Adjuvants, and Application Technology and 2) Environmental Aspects for their input in the same timeframe. Finally, we will send the edited version to the registrants and ultimately to our webpage for display over the next several weeks.

I am planning to use Google Docs to facilitate the review process. The document can be accessed at this link. We have also created a link to all of the PDF files of the 11 presentations that were made at the Workshop. Any comments that you would like to provide will show up as suggested edits or you can add comments through the “insert” menu. If you have any issues seeing the document, please let me know and I will try another method.

Thank you again for helping us understand the data gaps related to this technology. We will do our best to use this information to the betterment of our producers and scientific discipline.

Sincerely,

Scott SensemanPresident, Weed Science Society of America

Scott A. Senseman
Professor and Department Head
Department of Plant Sciences
2431 Joe Johnson Drive, 252 Ellington Plant Sciences Building
Knoxville, Tennessee 37996

865-974-8033 Office / 865-974-1947 Fax
scottsenseman@tennessee.edu | https://ag.tennessee.edu/plantsciences

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Keep in touch with alumni! Add Plant Sciences to your LinkedIN Profile https://lnkd.in/dANBcuz
Open in Docs

Delivery Report

From: Microsoft Outlook [MicrosoftExchange329e71ec88ae4615bbc36ab6ce41109e@usepa.onmicrosoft.com]
Sent: 9/10/2018 9:05:31 PM
To: jnorsworthy@uaex.edu
Subject: Undeliverable: formulation info
Attachments: formulation info

Your message
To: jnorsworthy@uaex.edu
CC: Kenny, Daniel
Subject: formulation info
Sent: 9/10/2018 9:05:29 PM

Office 365

Your message to jnorsworthy@uaex.edu couldn't be delivered.

jnorsworthy wasn't found at uaex.edu.

Rosenblatt.Dan	**Office 365**	**jnorsworthy**
Action Required		Recipient

Unknown To address

How to Fix It

The address might be misspelled or might not exist. Try one or more of the following:

- **Retype the recipient's address, then resend the message** - If you're using Outlook, open this non-delivery report message and click **Send Again** from the menu or ribbon. In Outlook on the web, select this message, and then click the "**To send this message again, click here.**" link located just above the message preview window. In the To or Cc line, delete and then retype the entire recipient's address (ignore any address suggestions). After typing the complete address, click **Send** to resend the message. If you're using an email program other than Outlook or Outlook on the web, follow its standard way for resending a message. Just be sure to delete and retype the recipient's entire address before resending it.
- **Remove the recipient from the recipient Auto-Complete List, then resend the message** - If you're using Outlook or Outlook on the web, follow the steps in the "Remove the recipient from the recipient Auto-Complete List" section of this article. Then resend the message. Be sure to delete and retype the recipient's entire address before clicking **Send**.
- **Contact the recipient by some other means,** (by phone, for example) to confirm you're using the right address. Ask them if they've set up an email forwarding rule that could be forwarding your message to an incorrect address.

If the problem continues, ask the recipient to tell their email admin about the problem, and give them the error (and the name of the server that reported it) shown below. It's likely that only the recipient's email admin can fix this problem.

Was this helpful? Send feedback to Microsoft.

More Info for Email Admins

Status code: 550 5.4.1

This error occurred because a message was sent to an email address hosted by Office 365, but the address doesn't exist in the receiving organization's Office 365 directory. Directory Based Edge Blocking (DBEB) is enabled for uaex.edu, and DBEB rejects messages addressed to recipients who don't exist in the receiving organization's Office 365 directory. This error is reported by the recipient domain's email server, but most often it can be fixed by the person who sent the message. If the steps in the **How to Fix It** section above don't fix the problem, and you're the email admin for the recipient, try one or more of the following:

Check that the email address exists and is correct - Confirm that the recipient address exists in your Office 365 directory, is correct, and is accepting messages.

Synchronize your directories - Make sure directory synchronization is working correctly, and that the recipient's email address exists in both Office 365 and in your on-premises directory.

Check for errant forwarding rules - Check for forwarding rules for the original recipient that might be trying to forward the message to an invalid address. Forwarding can be set up by an admin via mail flow rules or mailbox forwarding address settings, or by the recipient via the Forwarding or Inbox Rules features.

Make sure the recipient has a valid license - Make sure the recipient has an Office 365 license assigned to them. The recipient's email admin can use the Office 365 admin center to assign a license to them (Users > Active Users > Select the recipient > Assigned License > Edit).

Make sure that mail flow settings and MX records are correct - Misconfigured mail flow or MX record settings can cause this error. Check your Office 365 mail flow settings to make sure your domain and any mail flow connectors are set up correctly. Also, work with your domain registrar to make sure the MX records for your domain are set up correctly.

For more information and additional tips to fix this issue, see this article.

Original Message Details

Created Date:	9/10/2018 9:05:29 PM
Sender Address:	Rosenblatt.Dan@epa.gov
Recipient Address:	jnorsworthy@uaex.edu
Subject:	formulation info

Error Details

Reported error:	*550 5.4.1 [jnorsworthy@uaex.edu]: Recipient address rejected: Access denied [DM3NAM05FT016.eop-nam05.prod.protection.outlook.com]*
DSN generated by:	MW2PR0901MB2300.namprd09.prod.outlook.com

Remote server: DM3NAM05FT016.mail.protection.outlook.com

Message Hops

HOP	TIME (UTC)	FROM	TO	WITH
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2	9/10/2018 9:05:30 PM	BN7PR09MB2611.namprd09.prod.outlook.com	MW2PR0901MB2300.namprd09.prod.outlook.com	Microsoft SMTP Se cipher=TLS_ECDHE

Original Message Headers

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 h=From:Date:Subject:Message-ID:Content-Type:MIME-Version:X-MS-Exchange-SenderADCheck;
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 MW2PR0901MB2300.namprd09.prod.outlook.com (52.132.147.26) with Microsoft SMTP
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Received: from BN7PR09MB2611.namprd09.prod.outlook.com
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 ([fe80::f932:26d0:e632:2342%4]) with mapi id 15.20.1122.019; Mon, 10 Sep 2018
 21:05:29 +0000
From: "Rosenblatt, Daniel" <Rosenblatt.Dan@epa.gov>
To: "jnorsworthy@uaex.edu" <jnorsworthy@uaex.edu>
CC: "Kenny, Daniel" <Kenny.Dan@epa.gov>
Subject: formulation info
Thread-Topic: formulation info
Thread-Index: AdRJSYeCrIg9/GiuS/S2PwEzUQ5xgg==
Date: Mon, 10 Sep 2018 21:05:29 +0000
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received-spf: None (protection.outlook.com: epa.gov does not designate
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X-MS-Exchange-CrossTenant-originalarrivaltime: 10 Sep 2018 21:05:29.4082
(UTC)

X-MS-Exchange-CrossTenant-fromentityheader: Hosted

X-MS-Exchange-CrossTenant-id: 88b378b3-6748-4867-acf9-76aacbeca6a7

X-MS-Exchange-Transport-CrossTenantHeadersStamped: MW2PR0901MB2300

Message

From: Rosenblatt, Daniel [Rosenblatt.Dan@epa.gov]
Sent: 9/10/2018 9:05:29 PM
To: jnorsworthy@uaex.edu
CC: Kenny, Daniel [Kenny.Dan@epa.gov]
Subject: formulation info

Jason – do you happen to have formulation specific data on dicamba flux in any of your trials that you could send to EPA? I am especially interested in information on the new formulations. Thanks for looking into this.

Dan

Daniel J. Rosenblatt, Deputy Director,
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703-308-9366